July, 1941

THE Petroleum Engineer

VOL. XII NO.

THE PETROLEUM ENGINEER PUBLISHING CO. . . . Phone: Central-4571 . . . Seventh Floor Allen Building . . . DALLAS, TEXAS

Clarence Morris, President, 1929-40

A Magazine of Methods for Operating M

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MEMBER A. B. C.—A. B. P. (The articles in *The Petroleum Engineer* are indexed in the *Industrial Arts Index*, New York, N. Y.

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OIL COUNTRY
YOUNGSTOWN
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The Course of Oil

by K. C. SCLATER

Fallacy of Prolonged Shutdowns

Reservoir pressure in the East Texas field has been the cause of some concern since the release by the Railroad Commission of the latest figures on reservoir pressure drop in that field. An important question is raised of immediate interest to all producers in the field.

There has been talk of shutting-in production of the field for a period of two weeks in order to allow the reservoir pressure to build up. Shutting-in the field for a prolonged period is at best an expedient. True, it may build-up reservoir pressure, but such building-up can come only from hydrostatic pressure — pressure imposed by water drive from the west edge of the field. This method of building up pressure is not a desirable one, and the very fact that it is resorted to, is evidence that the rate of withdrawal — which includes oil and water — is too great. What is its significance? Just this: the flowing life of wells so producing will be shortened and the time hastened when the oil will have to be lifted by artificial means.

If the energy in the reservoir is to be prudently utilized for bringing the oil to the surface the rate of withdrawal from the field must be reduced. Either the amount of water produced with the oil will have to be restricted or the allowable oil production further reduced.

There is another factor to consider in a prolonged shutdown. Experience has shown that the greatest subsurface effect is the equalizing of reservoir pressure, the tangible result of which is an increase in bottom-hole pressure. It also may do irreparable damage to wells in the field already producing water. Such an increase of bottom-hole pressure is too often fallaciously interpreted as an increase in reservoir pressure. An increase of reservoir pressure would result from a lagging water drive from the west, but certainly could not come from the oil and gas in the reservoir. An increase in bottom-hole pressure is not necessarily an indication that the reservoir pressure has increased. So far as the average operator in the field is concerned, the value of maintaining reservoir pressure is to reduce his ultimate lifting costs and increase his ultimate production.

If the rate of reservoir pressure drop in the East Texas field can be retained by reducing the rate of withdrawal it is desirable to do so at once. Otherwise, early installation of pumping equipment and a reduction in allowable oil production may have to be faced. To delay taking action now may lead to another undesirable consequence—creating sooner than necessary a demand for pumping equipment that cannot be filled. The oil industry faces a possible growing shortage of pumping equipment. It seems folly therefore to pursue a course that is likely to aggravate this situation, particularly so if following such a course is contrary to sound engineering principles of reservoir control that not only will promote conservation but will redound to the ultimate benefit of all operators in the field.

Costs Given Consideration

After a brief hearing conducted in San Francisco on June 7, Federal representatives requested that crude oil and gasoline price increases in California of May 23 be restored to levels prevailing prior to that date. On June 9, the restoration of prices was postponed to July 1. A further postponement to July 15 was ordered later. Now the restoration of old prices has been postponed indefinitely.

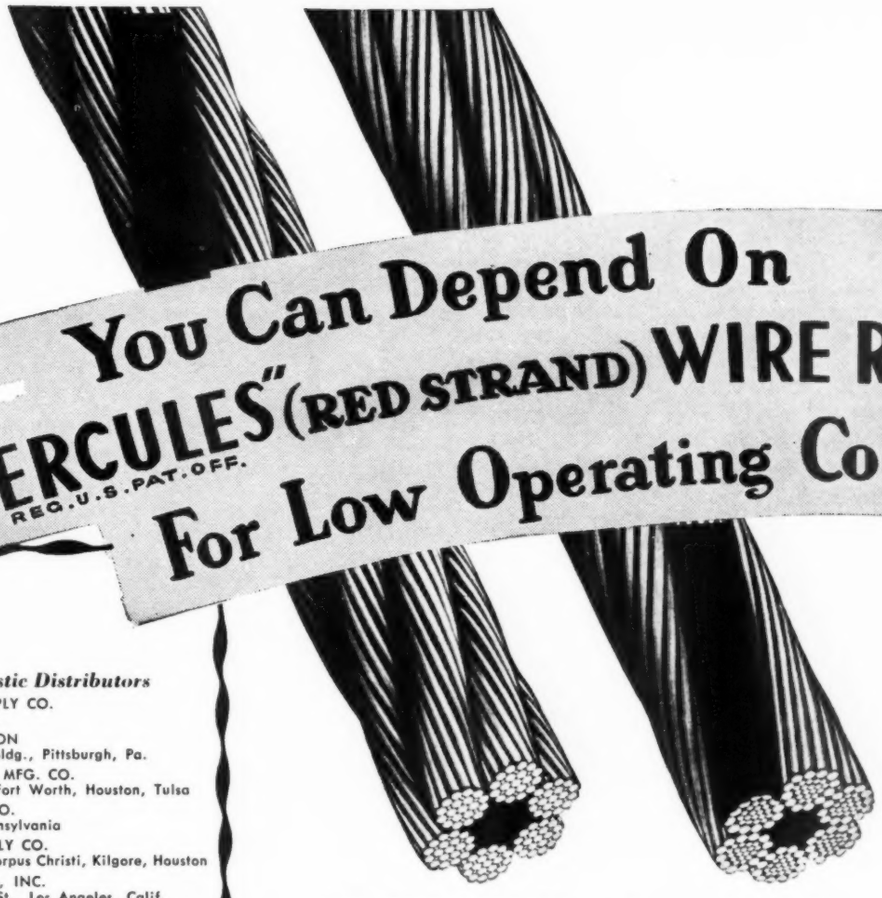
Oil producers in California have just received assurance from Leon Henderson, Price Administrator, that no reduction in prices would be requested at this time. It was understood assurance was given after producers agreed not to increase prices further without consultation with the Office of Price Administration and Civilian Supply.

After the date of the first postponement, the Oil Producers Agency of California got busy and sent out a questionnaire to more than 800 operators in California with the object of obtaining information on production costs in California. This information was brought to the attention of Washington. Increases in costs since 1934, it was believed, fully justified the recent price increases put into effect.

In addition to having this information, the Office of Price Administration and Civilian Supply sent out a cost questionnaire to California operators. The fact that they have seen fit to postpone the restoration of prices to old levels indicates that they received evidence of the justification for the price increases in California.

Price Administrator Leon Henderson apparently intends to deal firmly but fairly with industry. His office will endeavor to see that no price advance shall be prevented when it is contributing to their prime objective of increasing production and is not, at the same time, working against their other objectives in any significant fashion. He has stated this in public as one of the cardinal objectives of his office, and intends to provide freely for a modification of decisions if new facts are brought to its attention or if conditions change. On the question of profits he believes that neither the requirements of the defense program nor simple equity permits his office deliberately to force manufacturers to operate at a loss.

California operators have reason to feel gratified with the outcome of their case with Price Administrator Leon Henderson. This action will be hailed with satisfaction by the industry at large for the fair and impartial attitude shown in the pains taken to investigate the justification for a price increase of petroleum products.



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Highlights IN OILDOM

Present Case for the Stripper Well

The case for the stripper well has been outlined to Petroleum Coördinator Ickes by Charles P. McGaha, president, and H. B. Fell, executive vice-president, of the National Stripper Well Association.

In their statement, presented to Ickes in written form, it was mentioned that it had been "suggested by some" that if 50,000 stripper wells were abandoned there might be a beneficial result as the steel and other materials salvaged could be used in new wells or for national defense purposes.

"It must be recognized," wrote McGaha and Fell to Coordinator Ickes, "that such steel as might be salvaged from wells of this type is in most cases badly deteriorated and what is usable could, in most cases, only be utilized in very shallow wells as it is too light to be used in deep wells."

Recovery of material from abandoned wells would be inconsequential in comparison with the principal loss that would occur in natural resources, they pointed out. "It would seem absurd in the critical situation that now confronts our nation to abandon large known reserves in the hope of finding new reserves which are becoming increasingly difficult to recover," Fell and McGaha stated.

The economic factor stressed to the coördinator was that an adequate price is necessary to the continued operation of the small wells. In considerable measure, preservation of such wells is necessary to the preservation of the independent producer. McGaha and Fell reminded that in hearings before the temporary national economic committee it was developed that the 20 largest oil companies own less than one-fourth of the wells but produce more than half the oil.

"The independent operators produce a large portion of the total crude oil output and offer a safeguard against monopoly," the statement said. "In addition, this independent group is vitally important in the search for new reserves as shown by the fact that they drilled 72 percent of the total wells in 1940 and found 75 percent of the new fields discovered during the year."

Extension of Oil Compact Seems Assured

Charles L. Orr, secretary of the Interstate Oil Compact Commission, assures that the compact law will be extended by congress for another two years from September 21, when the present act expires.

Nine states have signed the recommendation to lengthen the life of the compact. Governor Leon C. Phillips of Oklahoma, chairman of the Compact Commission, will submit to President Roosevelt the proposal for extension until 1943.

Proration Laws of Texas Permanent

Texas' proration laws have been made permanent by acts of both branches of the state legislature and the signature of Governor O'Daniel. Heretofore the oil-conservation act has been in force for a period of only two years, necessitating its renewal at the end of that term, and presenting the recurring possibility of a break-down in the state's oil conservation program every two years.

Re-define Term Marginal Well

The Texas State Legislature has passed a bill re-defining the term marginal well, to include "any oil well which is incapable of producing its maximum capacity of oil except by pumping, gas-lift, or other means of artificial lift, and which well so equipped is capable under normal unrestricted operating conditions, of producing such daily quantities of oil as herein set out, as would be damaged, or result in a loss of production, ultimately recoverable, or cause the premature abandonment of same, if its maximum daily production were artificially curtailed."

The bill left unchanged the depth definitions, i.e., 10 bbl. from 2000 ft. or less; 20 bbl. from 2000 to 4000 ft.; 30 bbl. from 6000 to 8000 ft., and 35 bbl. from deeper than 8000 ft.

Deduction From Oil Runs Proposed

Humble Oil and Refining Company has proposed a new pipe-line rule (Rule 9) for Texas to take care of high gravity crude oils. The proposal was made recently at a statewide hearing before the Texas Railroad Commission. The existing rule, officials of Humble state, calls for corrections on deductions at the rate of 1 percent for every 25 deg. in temperature above and below 60°F. This is not accurate above 34.9 deg. gravity, it was said, and the following proposed new rule was offered:

"Rule 9. Gauging, Testing, and Deductions. All oil tendered to a pipe line for transportation shall be gauged and tested by a representative of the pipe line prior to its receipt from the shipper; and the shipper shall at all times have the privilege of being present or represented at the gauging and testing. Quantities shall be computed from correctly compiled tank tables showing 100 percentum of the full capacity of the tanks in all oil fields in Texas; and corrections will be made for temperature to the basis of 60°F. in accordance with the abridged volume correction table for petroleum oils contained in the supplement to the National Bureau of Standards Circular C410 issued April 20, 1937. Pipe lines may deduct the full percentum of basic sediment, water, and other impurities as shown by the centrifugal or other tests agreed upon. A further deduction of 1 percentum for evaporation and loss during transportation shall be made, and the net balance shall be the quantity deliverable by the pipe line. In allowing the deduction set-out in this rule, it is not the intention of the Commission to affect any tax or royalty obligations imposed by laws of Texas on any producer or shipper of oil."

No opposition to the proposal was offered except that John C. Jackson of The Texas Company asked that the amendment be "permissive" for 90 days, and thereafter mandatory, to allow time for revisions in tariffs.

Drilling Pattern for New Michigan Pool

The Michigan Oil Advisory Board has approved a 20-acre rectangular drilling pattern for the new Reed City pool. Per-well production is limited to 480 bbl. per day. This action was taken at a public hearing in Lansing recently and the final order will have to come from the State Conservation Department.

Provisions of the spacing recommendations are for 20-acre east-west units, with wells 660 ft. apart north-south, and 1320 ft. apart east and west. Wells completed or drilling on 10-acre locations at the time the order is made will be considered as 20-acre locations for proration purposes so long as only one well is drilled on the 20-acre unit.

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THE Ethyl Gasoline Corporation at the Baton Rouge, Louisiana, plant, has added a new process for making ethyl chloride from ethylene gas. Basically the unit is similar to the process used by the original plant built for converting refinery stabilizer gases into ethyl chloride.

A $300,000 propane plant, having a capacity of 3,000,000 cu. ft. of gas per day on 12-day periods, is to be constructed by Dominion Natural Gas Company near St. George, Ontario.

The gas will be used as a supplement to the natural gas supply of the company, which supplies gas to the communities of St. Thomas, Leamington, and Kingsville.

The Shell Oil Company natural gasoline plant in the Magnolia field, Columbia County, South Arkansas, is being enlarged to a total capacity of 20,000,000 cu. ft. of gas per day. Additions to the plant include two 485-hp. compressors, two boilers, one absorber, expansion of absorption oil circulation facilities, and propane storage.

Lion Oil Refining Company is providing for further utilization of the residue gas from the Shell plant by installation of a Girbotol treating plant. Lion has contracted for 15,000,000 cu. ft. daily for use at its El Dorado, Arkansas, plant and is installing compressors and lines to handle the gas.

Operation of the $400,000 cycling plant in the Schuler field of South Arkansas has begun by Lion Oil Refining Company. The company is operator of the unitized properties producing oil from the Jones sand in the field.

Due to the rapid drop of gas pressure in the field in the Jones sand, unitization of the wells has been necessary. All but six wells were unitized last February. It is estimated that 93 percent of the gas produced from the sand will be returned to the formation.

Installation of a new distillation unit, the capacity of which will depend upon the development of drilling in the Wilson Creek field, has been announced by G. O. Shefstead, superintendent of The Texas Company refinery at Craig, Colorado. Present capacity of the plant is 2000 bbl. with a Holmes-Manley unit. Other items on the improvement program include a new loading rack and safeguarding of the plant as a national defense unit.

A gasoline extraction and repressuring plant is under construction a few miles northwest of Albert, Oklahoma. The plant will cost approximately $75,000.

Natural gas from the Otis pool in Rush and Barton counties, western Kansas, will be cycled by the plant.

Negotiations are nearing completion for the construction of a $10,000,000 plant at the Standard Oil Company of Louisiana refinery at Baton Rouge for manufacturing butadiene, a principal material used in making synthetic rubber. Governor Sam Jones reported that M. J. Rathbone, president of the company from New York, said that contracts were being drawn up with the defense plant section of the Reconstruction Finance Corporation. Standard will spend about $7,750,000 to connect the plant with its large refinery facilities. The new plant will produce 15,000 tons annually of butadiene.

Standard is doubling the size of its $3,000,000 buna rubber plant recently placed in operation.

Construction has also begun on part of a $15,000,000 expansion by Standard announced several weeks ago. This plant will manufacture the newly-developed butyl rubber, also a synthetic rubber.

A. B. Cobb and Company have announced purchase of the Home Oil and Refining Company refinery at Great Falls, Montana, and the Pondera field properties of Rice Oil Company. Also acquired by Cobb was the 500-bbl. skimming plant at Conrad, Montana, which has been shut-down for several years. A pipe line from the Pondera properties to Conrad, 75 producing wells with a production of 450 bbl. per day, and retail outlets covering the Great Falls trade territory were included in the purchase.

Increase of the Great Falls refinery from 1500 bbl. to 3000 bbl. per day has begun. The plant, established in 1930, has been rebuilt and modernized several times. It has a polymerization unit and a road oil unit.

The machinery and all processing equipment of the Oil Creek Refining Company, Titusville, Pennsylvania, has been purchased by the Allegany Refiners, Inc., Bolivar, New York. The equipment will be moved to the local refinery as part of an expansion program authorized by stockholders last March. Allegany will have a complete lubricating-oil refinery and will be able to refine wax distillates into finished products.

Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks
Week Ended June 28, 1941
A.P.I. Figures

(Figures in thousands of bbl. of 42 gal. each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks	Total Gas and Fuel Oil Stocks
East Coast	100.0	600	93.3	22,888	17,661
Appalachian	91.0	141	99.3	2,993	888
Ind., Ill., Ky.	90.2	653	97.5	16,913	6,890
Okla., Kans., Mo.	76.9	307	95.0	7,475	3,480
Inland Texas	59.6	134	80.3	2,197	1,708
Texas Gulf	89.2	905	94.8	12,019	14,950
Louisiana Gulf	97.6	149	93.1	3,174	2,686
No. La. and Ark.	51.5	58	111.5	471	788
Rocky Mountain	56.0	53	77.9	1,560	664
California	87.3	591	81.0	15,421	76,653
Reported	86.2	3,591	91.8	85,111	126,368
Estimated Unreported	.....	339	.....	6,350	2,260
*EST'D TOTAL U. S. JUNE 28, 1941	.....	3,930	.....	(a)91,461	128,628
*EST'D TOTAL U. S. JUNE 21, 1941	.....	3,845	.....	91,916	129,017
U. S. B. of M. *JUNE 28, 1940	.....	**3,608	.....	94,298	137,392

*Estimated Bureau of Mines basis.
**June, 1940, daily average.
(a) Finished 83,586,000 bbl. ; unfinished 7,875,000 bbl.

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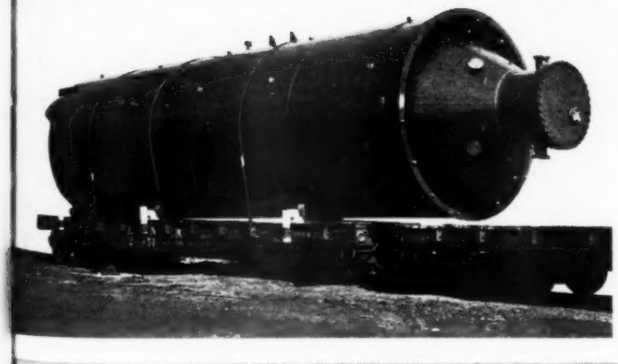

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TULSA.....1634 Hunt Bldg.	CLEVELAND...2251 Builder's Exchange	SAN FRANCISCO.....1064 Rialto Bldg.
BIRMINGHAM.....1570 N. 50th Street	PHILADELPHIA....1635-1700 Walnut St.	LOS ANGELES.....1446 Wm. Fox Bldg.

LICENSEES: Horton Steel Works, Limited, Fort Erie, Ontario, Canada; The Motherwell Bridge & Engineering Co., Ltd., Motherwell, Scotland; The Whessoe Foundry & Engineering Co., Ltd., London, England; Worms & Cie, Paris, France; Compagnia Tecnica Industrie Petroli, S.A.I. Rome, Italy.

MAJOR *Oil Field* ACTIVITIES

KANSAS oil production has apparently been extended some 25 miles west of the Nunn pool of Finney County, which previously was the farthest west production in the state, by the Stanolind Oil and Gas Company's well No. 1 Patterson, northwest Kearney County wildcat.

The well is located in CEL SE SE of 23-22-38. It has an estimated production of 1000 bbl. daily of 38-40 gravity oil producing from the lower Cherokee strata.

A discovery well flowing 12,000 bbl. of oil per day was brought in by Weber Oil Company in the Reed City pool of Osceola County, Michigan. The well is No. 1 Clark SW SE NE 30-18n-10w. The Dundee formation was topped at 3502 ft., casing set at 3571 ft., just above the Monroe pay zone, and the well then drilled to 3575 ft. where it first began to flow. For the first 2 hr. the well flowed 300 bbl. of oil per hr. During the next 2 hr. flow increased to 500 bbl.

Young County, Texas, has a new Mississippi lime pool which was opened by the T. D. Humphrey No. 1 E. G. Williamson, block 601, TE&I survey, a few miles southwest of Jean, Texas.

The well was perforated in the Mississippi zone by 19 shots from 4983 to 4990 ft., 20 shots from 4990 to 4996 ft., 20 shots from 4996 to 5003 ft., and 19 shots from 5003 to 5009 ft.

Mud had been bailed a few minutes when the well started natural flow through the casing.

A well drilled to 5310 ft. and making 15 bbl. per hr. of 43 gravity oil through a ¼-in. choke, opened a new oil pool by H. R. Scivally at No. 1 Louisiana Delta Lumber Company in SWC NE of 12-6n-4e, approximately 9 miles south of the Nebo pool of LaSalle Parish, central Louisiana. The well was drilled in the Wilcox sand of Cretaceous formation, and casing perforated from 4755 to 4760 ft.

Westgate-Greenland Oil Company No. 1 Rusch, in CE½ SE NE of 29-14-14w, a few miles southwest of the Hall-Gurney pool, Russell County, Kansas, acidized for a state potential of 3000 bbl. per day. Production is from the Arbuckle lime at 3222 ft.

In southern Hamilton County, southern Illinois, The Texas Company has apparently opened a new field. The company's No. 1 Alice McDonald, in NW NE SW of 11-6s-6e, and several miles west of the Dale pool, swabbed 83 bbl. of oil in 17 hr. from the Aux Vases sands at 3078 ft. Seven-inch casing was set at 3071 ft.

Two wildcats in Oklahoma counties of Noble and Stephens have proved discovery wells opening new fields. Superior Oil Company's No. 1 Faubian in Noble County, SE SW SE of 16-22-1e, flowed 205 bbl. of oil in 13 hr. through a ⅛-in. choke, producing from the Wilcox sand. This well opens production from the Wilcox north of the Otoe pool, which produces from the Layton sand.

Skelly Oil Company No. 1 Frensley, CNE NE of 35-1s-5w, flowed 160 bbl. of oil while swabbing, production being from the Simpson sand in the Velma area.

AVERAGE CRUDE OIL PRICES

California	
Kettleman Hills	$1.23-1.29
Playa Del Rey	.80- .87
Coalinga	.73-1.13
Wilmington	.68-1.24
Montana	1.00-1.15
Wyoming	.40-1.30
Colorado	.95- .97
New Mexico	.94-1.00
Texas	
North Central	.78-1.18
Panhandle	.70-1.12
West Texas	.70-1.12
Gulf Coast	.93-1.48
Darst Creek	1.14
East Texas	1.27
Talco	.79
Kansas	.70-1.25
Oklahoma	.70-1.25
Arkansas	.83-1.15
Louisiana	
Rodessa	.88-1.20
Gulf Coast	.95-1.48
North Louisiana	1.20-1.30
Illinois	1.22-1.37
Kentucky	1.32-1.43
Indiana	1.22
Ohio	
Lima	1.05
Michigan	1.11-1.45
Pennsylvania	
Bradford	2.75
Southwest	2.40
Eureka	2.34
Buckeye	2.30
Corning	1.31

DAILY AVERAGE CRUDE OIL PRODUCTION
Data Supplied by A.P.I.

(Figures in bbl. of 42 gal. each.)

	[1]B. of M Calculated Requirements (June)	Week Ended June 28, 1941	Week Ended May 31, 1941	Week Ended June 29, 1940
Oklahoma	459,700	[2]420,850	413,350	420,450
Kansas	220,400	[2]237,300	208,900	183,100
Nebraska	4,300	[2] 4,750	4,300	150
Panhandle Texas		82,450	77,800	61,250
North Texas		102,200	99,650	93,650
West Central Texas		30,850	30,000	30,650
West Texas		264,050	259,100	206,400
East Central Texas		80,600	79,500	72,600
East Texas		373,300	373,700	298,300
Southwest Texas		211,350	209,850	206,300
Coastal Texas		283,450	276,650	211,350
TOTAL TEXAS	1,371,700	1,428,250	1,406,250	1,180,500
North Louisiana		77,350	73,200	68,200
Coastal Louisiana		248,350	252,600	219,550
TOTAL LA.	319,700	325,700	325,800	287,750
Arkansas	83,000	72,700	73,200	72,350
Mississippi	23,300	[2] 28,500	27,500	9,650
Illinois	345,300	339,100	341,200	517,050
Indiana	22,000	[2] 21,300	22,000	13,250
Eastern (not incl. Ill. and Ind)	100,300	92,500	94,150	91,700
Michigan	38,000	37,800	38,000	56,400
Wyoming	89,300	77,700	85,150	79,300
Montana	19,700	19,250	19,050	19,850
Colorado	5,000	3,950	4,000	3,950
New Mexico	113,000	111,400	113,050	105,100
TOTAL EAST OF CALIF.	3,214,700	3,221,050	3,175,900	3,040,550
California	615,300	626,200	610,200	599,000
TOTAL U. S.	3,830,000	3,847,250	3,786,100	3,639,550

[1]These are U. S. Bureau of Mines' calculations of the requirements of domestic crude oil based upon certain premises outlined in its detailed forecast for the month of June. As requirements may be supplied either from stocks, or from new production, contemplated withdrawals from crude oil inventories must be deducted from the Bureau's estimated requirements to determine the amount of new crude to be produced.

[2]Oklahoma, Kansas, Nebraska, Mississippi, and Indiana figures are for week ended 7 a. m. June 25.

Engineered Cementing with Controlled Slurry

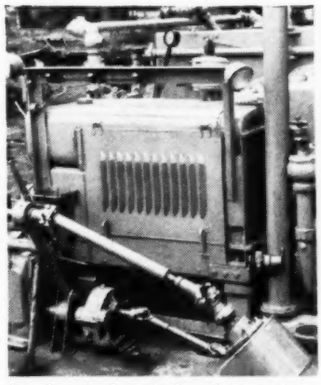
Acclaimed Greatest Contribution to Oil Industry Since Dowell Incorporated Announced Inhibited Acidizing

● Another phase of oil production has received the attention of Dowell engineering skill and research! The result is a cementing service so superior and so highly developed that the cement slurry can be mixed positively and continuously to a controlled density varying not more than a ± 0.1 lb. per gallon.

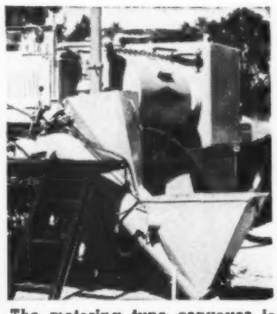
Engineered Cementing Service provides several important advantages that can be obtained only by using Dowell equipment and technique. This service assures operators of an accurate control of the water/cement ratio with positive, known thickening time; known initial and final setting time and known final strength of set cement; most reliable selection and efficient use of auxiliary materials; advanced money saving techniques, such as accomplished with Jelflake, whereby cement slurry is spotted up the hole above highly permeable horizons, without the use of added mechanical tools.

Engineered Cementing Service properly and permanently anchors the casing in the well and provides protection for producing zones from upper water and cavings; casing against external collapse and the corrosive action of mineral water; shallow water sands bearing domestic water supplies; shallow oil or gas sands behind the pipe; high pressure zones behind the cemented section; formations from fluid migrations.

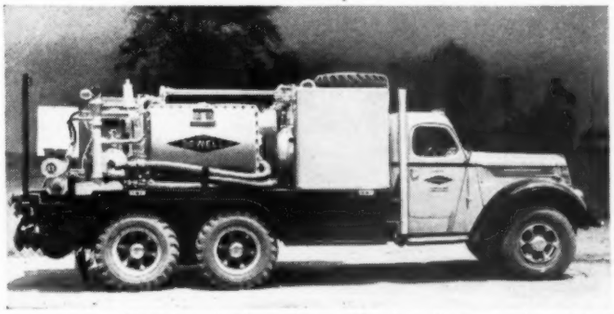
For further information concerning this revolutionary type of cementing service, telephone your local Dowell representative or write DOWELL INCORPORATED, Kennedy Building, Tulsa, Oklahoma.



Synchronized control and proportioning of water, cement and additive materials assure a smooth uniform slurry.



The metering type conveyor is mounted on chassis by turret head arrangement—it can be swung to the ground at most convenient point for loading with cement. Dry cement, in required quantity, is mechanically conveyed to mixer. By changing the speed of the mechanized conveyor, desired amounts of cement are fed to the mixer.



Engineered Cementing unit—six wheel, tandem drive, heavy-duty, powered with high capacity motor. Equipped with special winching assembly including a Dowell winch-cable outrigger, permitting forward or rear winching operation from either side or center of truck.

Measuring line and wrap-around type meter equipment which is mounted in a special service car and accompanies every Dowell cementing unit.

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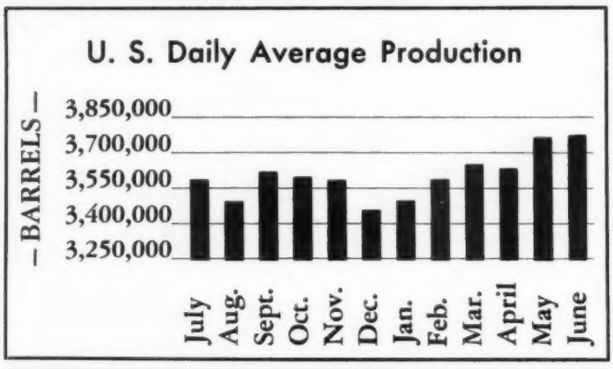
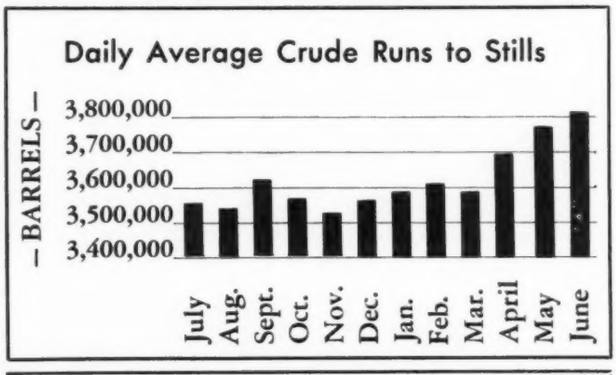
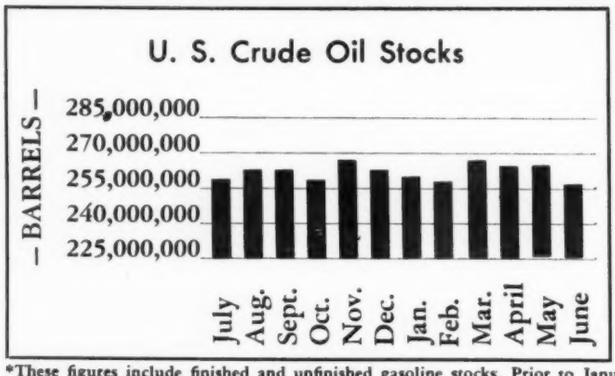
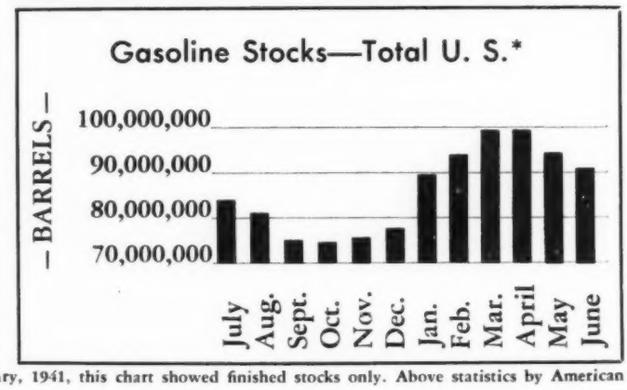
PETROLEUM *Statistics* AND FIELD *Operations*









*These figures include finished and unfinished gasoline stocks. Prior to January, 1941, this chart showed finished stocks only. Above statistics by American Petroleum Institute.

Summarized Operations in Active Fields for June, 1941

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	99	76	13	27	3500-3700	2	40	Rotary
Gaines County	18	17	4	13	4400-5584	2	22-35	Rotary
Hockley County	31	30	7	23	4800-6850	2	20-30	Rotary
Ector County	32	31	13	39	3675-4377	2 or 3	32-36	Rot.-Cab.
Panhandle	48	48	20	70	1700-3900	2	40	Rotary
Nueces County	25	18	4	16	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	16	15	7	25	3730-3935	2	42-43	Rot.-Cab.
Hawkins Field	22	22	12	18	4495-4912	2	19-29	Rotary
OKLAHOMA								
Okfuskee County	19	16	11	6	2150-4125	2 or 3	38	Rotary
KANSAS								
Russell County	41	30	9	19	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	17	11	4	13	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	29	18	14	25	3290-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	357	280	288	228	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	10	8	8	14	3150-4030	3	30-34	Rot.-Cab.
CALIFORNIA								
Kern County	32	27	15	18	1840-11,450	3 or 4	14-30	Rotary
Wilmington	15	15	8	7	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for June, 1941

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1940 (In Barrels)
	June	May	June	May	June	May	June	May	June	May	
Arkansas	16	14	10	11	16	15	8	6	34	30	25,699,000
California	97	109	86	104	119	99	97	106	156	161	224,029,000
Colorado	13	1	11	1	....	....	15	3	35	30	1,369,788
Illinois	357	280	280	221	395	404	288	243	141	132	146,572,938
Indiana	38	60	20	35	40	....	20	13	72	78	4,946,384
Kansas	187	235	137	166	258	204	40	43	288	301	65,602,452
Kentucky	28	39	15	20	32	....	9	10	88	96	5,282,335
Louisiana	105	145	75	100	150	157	45	50	270	295	103,738,728
Michigan	56	74	32	24	65	66	37	40	146	153	19,768,984
Mississippi	14	26	12	18	....	....	8	5	33	35	4,313,159
Montana	16	9	14	9	....	....	8	3	31	30	6,663,872
Nebraska	4	11	2	6	15	9	4	4	12	18	267,533
New Mexico	20	34	16	28	35	30	21	19	94	107	38,893,898
New York	94*	83*	94*	83*	....	....	14	11	80	81	4,240,441
Ohio	136	134	98	98	....	....	47	43	190	186	3,132,280
Oklahoma	180	221	132	162	203	171	61	57	195	304	152,516,049
Pennsylvania	207*	272*	198*	257*	....	....	13	15	79	93	17,987,217
Texas	810	1015	630	776	1247	803	718	721	1845	1973	490,101,261
West Virginia	44	60	40	57	....	....	18	23	149	165	3,586,653
Wyoming	16	7	15	7	....	....	17	11	16	57	25,863,538
Total	2438	2829	1917	2173	2575	1928	1488	1426	3954	4325	1,344,576,159

*Includes water-intake and pressure wells.

Our part in National Defense

Nixon Surface Control Gas-Lift System is making a dual contribution to National Defense.

In its role as an efficient, economical means of lifting oil to the surface it is giving operators assurance of being prepared to produce any well's maximum volume with few if any changes or additions to the original installation.

The Nixon Surface Control Gas-Lift System requires a minimum of parts in its fluid-lifting operation. The manufacture of these parts uses only small quantities of metals and materials being conserved for National Defense.

Our gas-lift engineers are able to make a successful installation in any oil well. It will pay to talk to one of them today.

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Surface Control
GAS-LIFT SYSTEM
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Reissue No. 21,199

2,132,081	2,171,812	2,245,005
2,164,469	2,204,817	2,245,006
2,171,478	2,245,002	2,245,008
2,171,480	2,245,003	2,245,009
2,202,462	2,245,004	2,245,010

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MAJOR *Pipe Line* ACTIVITIES

KANSAS pipe line capacity will be increased from 230,000 to 280,000 bbl. per day by four purchasing companies, who plan construction of new lines to end possibilities of transportation shortage. Socony-Vacuum Oil Company, Inc., White Eagle Division, will build 23½ miles of 10-in. line in Rice County for a 28,000 bbl. increase in capacity. Thirty-seven miles of 10-in. pipe line in Barton and Rice counties, to increase capacity about 25,000 bbl., will be laid by the Kaw Pipe Line Company. Kaw will also lay 30 miles of 6-in. connecting line in Rooks, Ellis, and Phillips counties; however, with present pumping equipment there will be no increase in capacity.

Thirty-three miles of 6 in. pipe line will be laid by the Skelly Oil Company in Barton and Russell counties as a connecting line.

A 6000-bbl. increase to its system has been made by Phillips Petroleum Company by completion of 5½ miles of 6-in. pipe line near McPherson.

Contract for the construction of a gasoline line from Fort Worth, Texas, to Dallas, Texas, has been let by Sinclair Refining Company to the Monarch Construction Company. Work began July 1 on the 3-in., 30-mile carrier. The line will terminate at the Sinclair wholesale distributing station.

The Gulf Refining Company, transportation division of Gulf Oil Corporation, has awarded contracts for the construction of 13 separate loops on its 732-mile, 10-in. pipe line from Jenks, Tulsa County, Oklahoma, to Cincinnati and Toledo, Ohio, and Pittsburgh, Pennsylvania. Contracts were let to Williams Brothers Corporation, Tulsa, Oklahoma; Jones and Brooks, Inc., Oklahoma City, Oklahoma, and the B. and M. Construction Company, Oklahoma City, Oklahoma. Williams Brothers will construct the three Oklahoma loops, B. and M. will lay the four loops in Missouri, and Jones and Brooks the remaining six loops in Illinois and Indiana.

The Natural Gas Pipeline Company of America has awarded a contract to W. A. Bechtel Company for construction of additional river crossings in Iowa. H. C. Price Company of Bartlesville, Oklahoma, has contracted for welding the line.

A 36-mile extension of the present 16-mile, 6-in. pipe line of the Pure Oil Company will be laid from the Cumberland field in Bryan and Marshall counties, Oklahoma, to the Fitts pool of Pontotoc County.

Details of the line and its route have been planned by R. E. Young, manager of Pure pipe lines for the Mid-Continent area.

The extension will permit the company to move its own production from the above named fields either to the Chicago, Illinois, market or to the Smith Bluff's refinery, near Beaumont, Texas, terminus of the company's Oklahoma output.

Magnolia Petroleum Company has announced work on a natural gas pipe line from the West Ranch pool, Jackson County, Texas, with a completion date of November 1. The company withdrew from this activity in 1929 with the disposal of transportation systems and sales and purchase contracts to the United Gas Pipe Line Company.

One-hundred-ninety miles in length, the new line will be 160 miles of 14-in. and 30 miles of 16-in. welded line.

Magnolia already has a crude oil line in operation from the pool.

Twenty-five miles of 8-in. and 10-in. pipe line will be laid for The Illinois Pipe Line Company near Enfield, Illinois, by Sheehan Pipe Line Construction Company and H. C. Price Company. The same two companies will also construct 133 miles of 8-in. pipe line from Indianapolis, Indiana, to Hammond, Indiana. Sheehan will be the general contractor and Price will have the welding.

Detailed study of a plan to construct 4450 miles of pipe lines is being made by Petroleum Coördinator Harold Ickes to avoid a transportation shortage of petroleum to the east. Final completion of plans for the lines is pending passage of the Cole bill by the Senate committee.

Two of the pipe lines considered would have the capacity of a fleet of 70 fast tankers—500,000 bbl. per day.

A pipe line of 250,000-bbl. capacity is proposed to be laid from Texas City and Port Arthur, Texas, to a point in New Jersey to transport gasoline and fuel oil. Sixteen hundred miles in length, the line would cost approximately $70,000,000.

In the original plans for the new pipe lines was a suggestion for a crude oil line from Shreveport, Louisiana, to be laid parallel to the gasoline line; however, it now appears that this proposal has been changed for a 900-mile pipe line to the Illinois oil fields, which will deliver 250,000 bbl. of crude oil to New Jersey.

With crude oil lines in the past seldom more than 18 in. in diameter, these two new lines are unusually large—the size pipe to be used of from 20 to 26 in. diameter.

Completed except for intervals consisting of rights-of-way across railroads, is the pipe line, 500 miles in length, from Port St. Joe, Florida, to the industrial area of Chattanooga, Tennessee. Operation of this line should begin soon.

Construction on a second "defense pipe line," that of the Plantation Pipe Line Company from Baton Rouge, Louisiana, to Greensboro, North Carolina, and probably to Norfolk, Virginia, is underway. With its final completion also dependent on rights-of-way across railroads, the government has classified the line as a "vital defense necessity" to facilitate construction.

This 1261-mile line was originally planned for a delivery capacity of 33,000 bbl. per day of refined petroleum products, but a revision of plans has changed this capacity to 60,000 bbl. per day. To obtain its maximum capacity of 90,000 bbl. per day, additional pumping stations to the 15 planned must be added. When completed the use of from 10 to 15 tankers will be eliminated by the line.

After leaving Louisiana the line will pass through Mississippi, Alabama, Georgia, South Carolina, and North Carolina. A branch line will make deliveries in Tennessee at Chattanooga and Knoxville. Deliveries in Mississippi will be made at Meridian. Moundville and Oxford are delivery points in Alabama on the main line whereas branch lines will serve Birmingham and Montgomery. Nine percent of the total area of the Nation will be served by this line.

Williams Brothers Corporation, Tulsa, Oklahoma, and Oklahoma Contracting Company, Dallas, Texas, will begin work soon on a 250-mile pipe line, 12 in. in diameter, from Portland, Maine, to refineries at Montreal. The line will eliminate a 2000-mile route followed by tankers for transportation of crude oil.

A reversal in direction of flow has been planned for the pipe lines delivering gasoline to Buffalo, New York, and Detroit, Michigan, from Bayonne, New Jersey. Buffalo may become the terminal port for shipments of crude oil and Michigan, Illinois, and Indiana crude oil may be transmitted by pipe line by way of Detroit to Bayonne refineries.

P 404.2
P 516.22

THE Petroleum Engineer

JULY, 1941

Automatic Control of Internal-Combustion Engine Temperatures

PETROLEUM ENGINEER Exclusive Feature

☆ Control of air circulated through radiator rather than volume of water through engine is basis of new designs

by Wallace A. Sawdon
Pacific Coast and Foreign Editor

OVER-HEATING and over-cooling are both detrimental to internal-combustion engine performance and have a definite effect on the life of a number of the component parts of engine construction. Probably all the internal-combustion engines used in the oil industry are primarily cooled with liquid circulation augmented by air circulation induced by a fan that removes the radiated heat from the liquid as the air passes through the radiator. Automatic temperature control of such engines has heretofore been obtained by a thermostat placed in the liquid circulation system to increase or decrease the flow of the liquid as the temperature increases or decreases. In a number of recent installations, however, temperature control has been obtained by regulation of the flow of air that carries off the radiated heat and passes air of atmospheric temperature through the radiator.

Engine temperature is greatly affected by the load and/or by the atmospheric temperature. Knowing the maximum load to be carried by the engine and the highest atmospheric temperature to be encountered at an installation of a stationary engine or at any place where the engine may be required to operate, it is relatively easy to provide a fan capable of delivering the necessary air circulation to keep the engine cool enough for efficient operation under maximum heat-producing conditions. A great many engines being used in the oil industry, however, operate under widely varying loads and frequently in places where the changes in atmospheric temperature are very pronounced, even over periods of one day as well as in seasonal changes throughout the year. The problem then becomes one of maintaining a desired engine temperature at all times.

Operating Conditions

With adequate provision against over-heating assured, over-cooling often results as the flow of air, although reduced somewhat by slower engine speed, may cool the engine to a point below desired engine temperature when the load is off. When constant load and engine speed conditions are maintained but when atmospheric temperature changes are appreciable, the air flow is established, of course, by the highest atmospheric temperature and is increasingly excessive as atmospheric temperature decreases. Shutters, either manually or automatically operated, are sometimes used to reduce the passage of cold air through the radiator but it would appear that automatic control of the flow of air should give more positive results.

The flow of air produced by the rotation of a fan depends on the pitch of the blades of the fan. By applying the same principles as those used in controllable pitch propellers on airplanes, the pitch of fan blades can be automatically changed to govern the flow of air produced by the fan. Inasmuch as engine temperature is the factor governing the desired flow of air it is therefore necessary to control the pitch of the blades thermostatically. A fan incorporating these features has recently been developed and installations

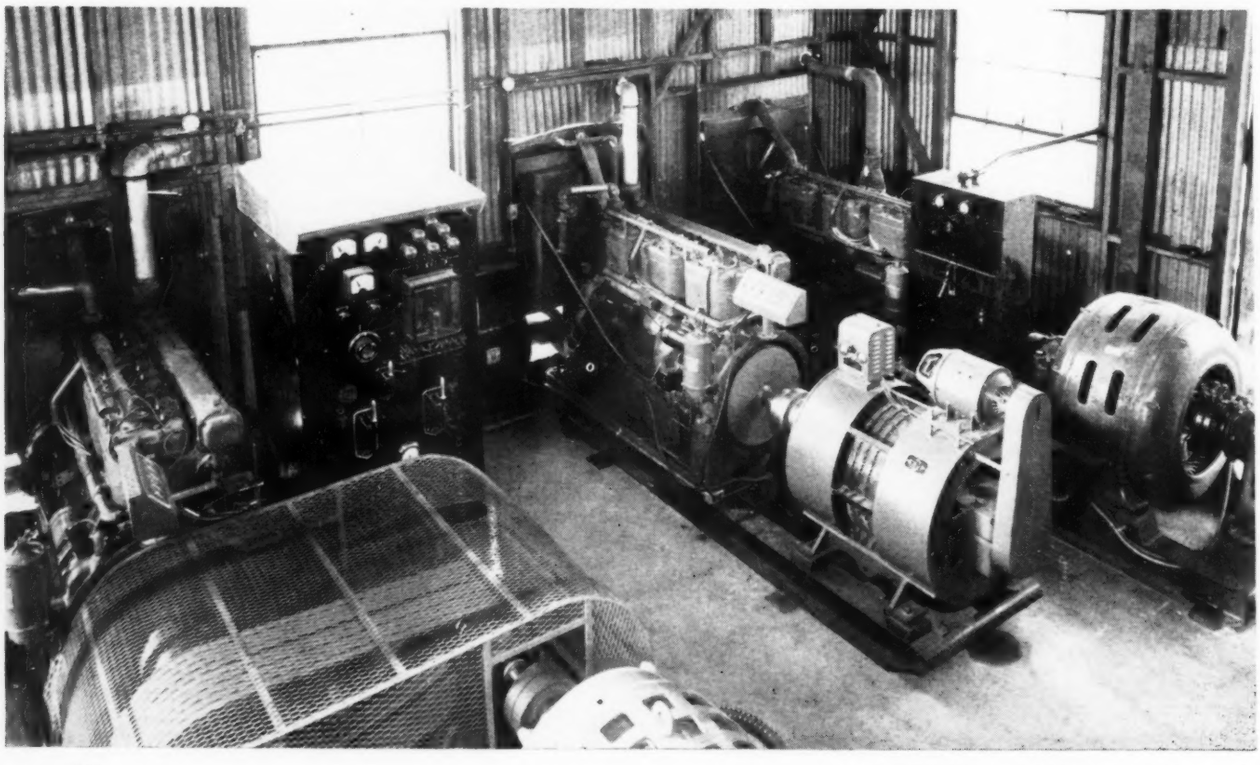
Despite variable temperatures of ocean breezes to which this pumping engine is subjected, adequate control maintains constant water temperature during continuous operation

during the last few months have indicated its adaptability to a number of oil industry applications. Being essentially a temperature control device, the assembly consists of a fan with variable pitch blades and an air-actuated, metallic, bellows-type thermostat. The thermostat is mounted in the hub and there is no thermostat in the liquid circulation system. The thermostat itself is filled with special liquid that is selected to provide control at any predetermined temperature. The thermostatic action is accurately computed by multiplying the number of inches of effective area of the thermostat by the known pressure per sq. in. of the liquid being used at the predetermined temperature. When it is desired to alter the temperature maintained, a thermostat for the new temperature merely replaces the old one.

Fan Blade Design

The fan blades are an air-foil design shaped of one-piece duralumin riveted to blade arms that are counterweighted for balance. The blade arms

The temperature of the water circulated in these three engines driving electric generators is maintained within a range of 176 to 188° F.



revolve in the hub on bearings from zero pitch to full pitch. Rotation of the blades and maintenance at any intermediate stage between zero and full pitch is controlled through an actuating pin and sleeve by the expansion of the bellows of the metallic thermostat in the center of the hub.

Inasmuch as temperature control is obtained by regulation of the air flow there is constant circulation in the liquid circulation system. This eliminates the hazard of cracking the engine block by the sudden inrush of cold water. The thermostat itself is not in contact with water and is thus not subject to rust or other influences that may make it inoperative.

Fans of size and number of blades adequate for the heaviest loads or highest atmospheric temperatures are installed. By tests made at the California Institute of Technology, it was found that the horsepower required to operate the fan was approximately proportional to the pitch of the blade. With a 22-in., 4-blade fan, with blades 3½ in. wide and running at 2050 r.p.m., the following driving horsepower was found necessary:

Blade position	*Driving hp.*
Full pitch	3.7
Approximately half-pitch	1.6
Zero pitch	0.5

There is thus a saving in power proportionate to the decrease in air flow. The horsepower required at full pitch can be compared to that required by a conventional fan of equal size.

Over-cooling or the running cold of an internal-combustion engine is probably not given the consideration that it deserves. In addition to the danger from the inrush of cold water when a load is applied to an engine that has been running cold there is the matter of sludging and oil dilution that frequently results from condenstion when an even temperature is not maintained in the upper and lower parts of the engine. By close control of temperature at the proper degree the oil is kept in better condition and necessary oil changes are less frequent. The maintenance of an even temperature also assures a more uniform expansion and contraction of cylinder bore that reduces the distortion of piston and cylinders.

Effect of Load Variation

An example of the effect of overcooling due to a minimum load at the coolest part of the day is a generating plant in Los Angeles supplying power for two pumping wells and the operation of several industries on an 11-acre tract. Here the load is at a maximum during the evening and tapers off to little more than that required for pumping the wells in the early morning hours when the atmospheric temperature is lowest.

Despite extreme speed variations in bailing service, water temperature in engine is maintained at 176-188° F. by controlling air volume passing through radiator

Power for the generators is supplied by three 150-hp., 6-cylinder gas engines taking fuel from gas wells on the tract. The engines were formerly equipped with conventional fans—two blowers and one suction type, the suction fan being installed to get hot air into the engine room. Two of the engines were on continuous duty and the third was thrown in for the peak load. Attempts were made to control the air flow manually but the temperature of the engine equipped with the suction fan would remain at from 100° to 130°F. and that of the other two from 120° to 140°F. during the period of minimum load when the atmospheric temperature was lowest.

The engines were then equipped with controllable pitch fans, all of the blower type. The automatic control was adjusted to maintain the temperature within the range of 176° to 188°F. at all times whether the engines were running at idling speed or handling peak load. Oil changes were previously made every 30 days but now are being made after 90 days or longer of continuous operation. Analysis of the oil after a 90-day period shows but a trace of water and a negligible amount of sulphur. Detrimental effects caused by the formation of sulphuric acid in

the crankcase oil appear to be reduced to a minimum by keeping the engine temperature constant within predetermined operating limits and maintaining an even temperature in the upper and lower parts of the engine.

Heavy-Duty Service

Hoisting service imposes a severe duty on an internal-combustion engine and loads are suddenly applied after periods of idling. A controllable pitch fan was installed on a portable servicing hoist that is used extensively for bailing—service in which the engine runs at idling speed while the bailer is going in the hole and is then thrown into high speed for pulling up. This outfit, shown in an accompanying photograph, had cracked three cylinder heads in the engine in a relatively short period of service but has not experienced such trouble in the three months since the new temperature control equipment was installed.

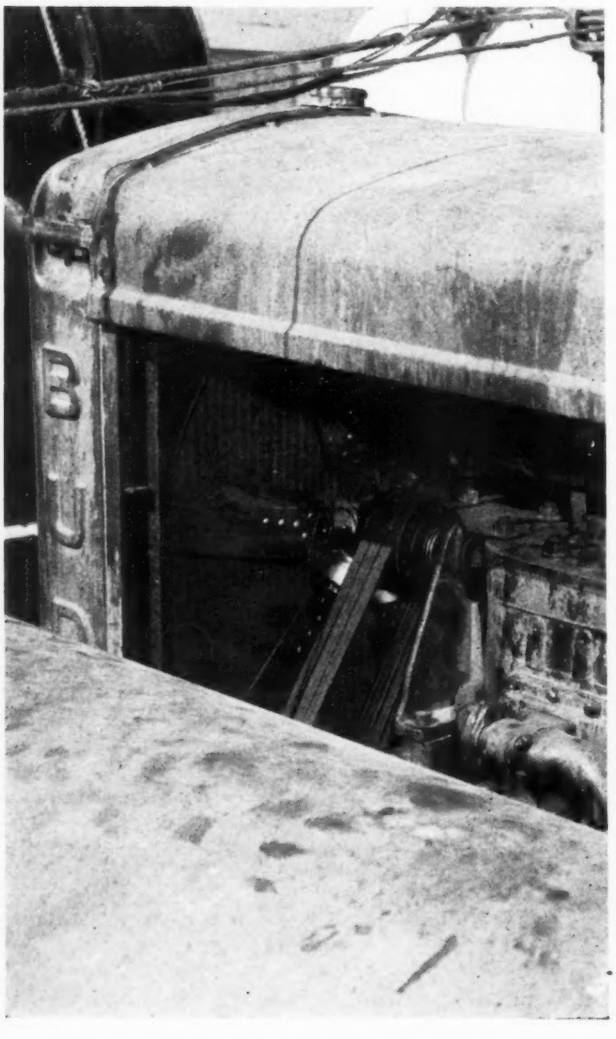
The pumping well shown in another illustration is near the ocean at Huntington Beach and the radiator faces the water. Variations in atmospheric temperature cause the engine to run cold during part of the day and if allowed to cool it was found that condensate contaminated the lubricating oil. By equipping the engine with a controllable pitch fan, the engine temperature has been held at a maximum of 176°F. and from 158° to 161°F. as the minimum. After a period of 40 days of continuous pumping the crankcase oil was analyzed and found to contain less than 0.01 percent water by distillation and 0.29 percent sulphur.

New Developments

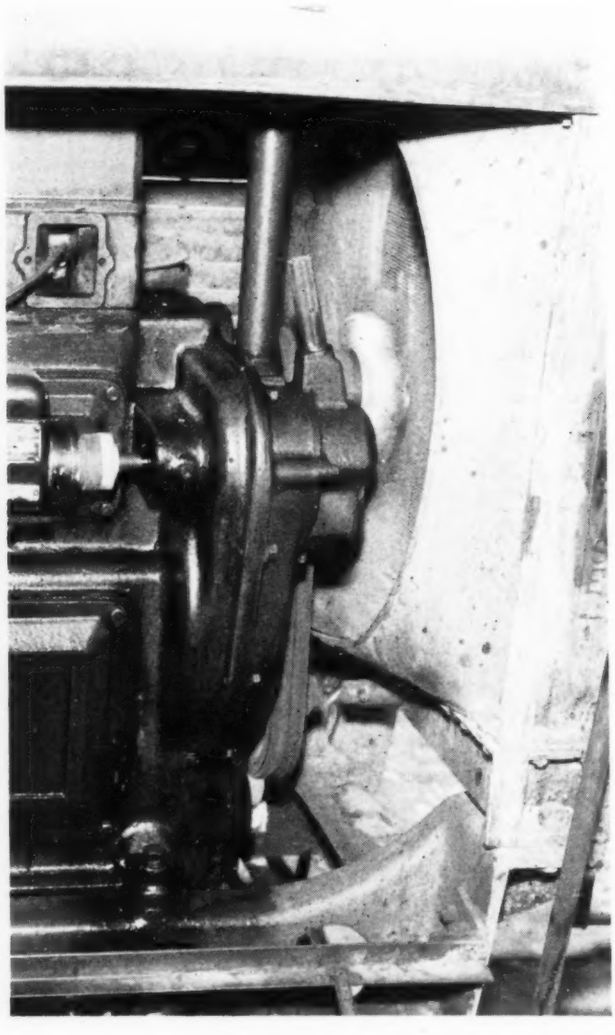
Cementing of oil wells at the great depths now attained requires fast mixing and rapid displacement of the slurry, sometimes with considerable final pressure. Portable cementing equipment, however, must be able to handle all kinds of jobs and a truck servicing an extensive territory must operate in many different atmospheric temperatures and at different altitudes. A new combination truck and trailer recently developed by Halliburton Oil Well Cementing Company that provides complete flexibility of operation employs temperature control for a mixing pump that must operate under a wide range of conditions.

This mixing pump is driven by an 8-cylinder gasoline engine. The radiator, however, is the kind use on trucks and cools 518 cu. in. as against the 320 cu. in. capacity of the engine as great cooling ability must be provided to meet any contingency that may arise. A controlled pitch fan adaptable to the radiator was installed in order to provide the necessary air flow for cooling under maximum load or highest atmospheric temperature and yet prevent over-cooling under minimum load and lowest temperature.

Showing the construction of variable pitch fan blades



Pitch of blades is automatically varied while engine is operating



Making a tie-in weld

Exclusive

by Frank H. Love

Managing Editor

New Louisiana Gas Line Augments Southern Natural's Supply

☆ Heavy-walled pipe used in three major river crossings in lieu of clamps

TO PROVIDE a new source of gas supply required by its system, Southern Natural Gas Company, whose headquarters are in Birmingham, Alabama, is laying a 14-in. line from Logansport, Louisiana, to Perryville, Louisiana. Gas will be taken from the Joaquin-Logansport field of Louisiana and Texas. At Perryville the line will connect with the company's existing system.

Although work began some time ago, progress has been slow because of rains and to date approximately half of the 140-mile line has been laid.

The route of the new line is northeast from Logansport and for the most part is through sandy soil that gives considerable trouble from caving ditch and has necessitated the use of clamshell-type mechanical shovels in numerous instances to remove the soil before pipe can be lowered-in.

One spread, working out of Ruston, Louisiana, began the work; later a second crew working out of Logansport augmented the construction force.

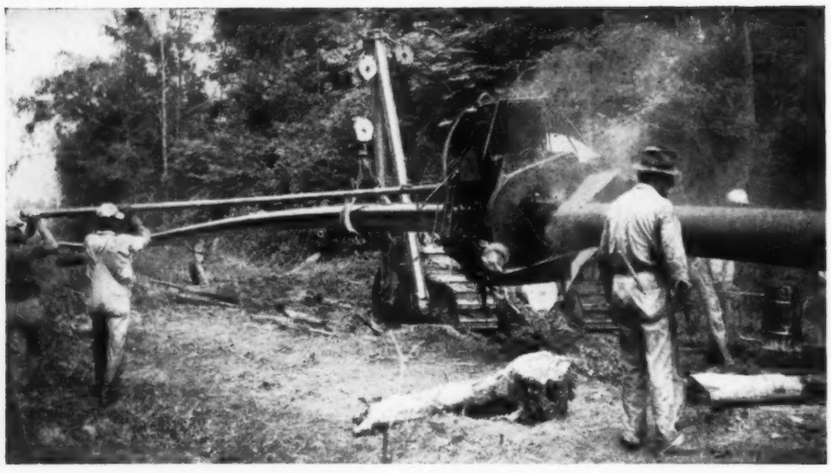
Digging a trench 30 in. wide and 44 in. deep

Construction Procedure

Customary procedure, exemplifying modern practice in pipelining, was observed. Pipe was strung by trucks from convenient shipping points after the right-of-way had been cleared. The ditching machines cut a trench 30 in. wide and 44 in. deep, giving the pipe a 30-in. covering, more than is customary for this size pipe. The trench also is of greater than usual width, making possible the crowding-in of more slack to care for expansion and contraction.

Firing-line welding will be employed throughout, three beads being run on the firing line and four beads on bell-hole welds tying-in the stalks or sections of line. Each spread uses five welding machines for tying-in and six on the firing line.

After the sections of pipe are tied-into the line a cleaning machine with priming head attached is run to remove accumulated dirt and rust and apply the primer coat. Following this step hot coating is applied by a self-propelling type machine. This machine applies an asbestos felt wrapper as well as the coating in one operation when desired. The line will be coated over its entire length but will be wrapped



The entire line was coated and in swampy areas a wrapper also was applied

A bulldozer moves timber and heavy boulders from the right-of-way as a part of the "clean-up" work after the line is laid

Cleaning and priming the pipe

only in the swampy areas. Approximately 40 miles will be so wrapped. A holiday detector is run to determine breaks in the coating, which are immediately repaired by hand.

To the topside of the pipe, coated but not wrapped, white paint is applied as a protection from the sun's rays to prevent the coating from running. As it is sometimes necessary that certain sections of pipe remain on skids above the ditch for several hours in the blazing sun before being lowered-in, this is important as danger of the coating thinning and causing breaks on the top and sides of the pipe is great.

Lowering of the pipe is accomplished by tractors equipped with winches after which the ditch is backfilled, slack loops being left "up" to lower in the cool of the morning when the pipe is fully contracted.

River and Highway Crossings

During construction of the line it will be necessary to make three river crossings; the Ouachita River, Red River, and Sabine River. These will be multiple crossings consisting of two 10-in. lines. The rivers are narrow enough that the strings of pipe can be welded on dry ground and pulled across by tractors and winches; barges will not be required for the work. River clamps will not be used as is the customary practice. Instead, heavy pipe with ¾-in. wall thickness will be used, which will be sufficient of its own weight to counteract buoyancy. The river pipe will be allowed to rest on the bottom of the streams, to receive covering from the silt deposited by the river.

All state highways are being cased with 18-in. casing and vents provided. The pipe in such highway crossings is coated but not wrapped. Contract requirements also call for a minimum pipe covering of 30 in. at the crossings. Gate valves (10 in.) are being set at strategic points, their spacing being on an average of every seven miles. It is also specified that bends be made cold whenever possible.

When completed the line will be tested in two sections with 1400-lb. gas pressure. The section on the east end of the line will be from Bienville to Perryville, a distance of 65 miles; the west section will extend 75 miles, from Logansport to Bienville.

B. and M. Construction Company of Okahoma City, Oklahoma, is the construction contractor; Ford, Bacon and Davis of New York City is acting in the capacity of supervising engineers, and H. C. Price Company of Bartlesville, Oklahoma, has the contract for electric welding.

Estimation of Underground Reserves of Petroleum[1]

PART 3 (Concluded)

by B. B. Bilibin

Determining Areal Extent of Reservoirs

THE determination of the size (area) of a probable oil-bearing reservoir is one of the most difficult tasks in reserve calculations. In order to arrive at a method for determining the oil-bearing area of a probable oil-bearing structure considerable research still must be carried out. It is possible that detail studies will show that the heights (closures) of oil reservoirs in similar geological structures will not differ materially from one another and consequently an idea of the height of a reservoir in undeveloped oil-bearing areas may be gained from a study of structures of known dimensions.

If, however, the studies show that the heights of the oil-bearing parts of reservoir structures in the same geological formations are not similar it will become necessary to investigate all evidence that might aid in revealing the possible relationship between the height of the oil-bearing part of a structure (h, Fig. 3) and the height H of the reservoir system. Perhaps the relationship between h and H, as determined from the best information available will be found to follow an approximate physical law for certain definite structural forms, or the study may show why the ratio of h to H differs in the same geological formation. In any case, this type of research may lead to some conclusion regarding the possible relationship between h and H and should be conducted on all known reservoirs and the results analyzed carefully for a clue as to the relationship between them. It seems difficult to believe that an exhaustive study of the possible relationship between h and H, based on geophysical investigations and geological interpretations, will not in time yield information of material aid in determining the heights of oil-bearing structures in likely oil-bearing areas.

If from such a study the height of an undeveloped reservoir can be approximated, it will be possible to calculate the approximate area of the oil-bearing parts of the reservoir system by including a consideration of the dip of the formation. As it is now, it is impossible to calculate the area of prospective reservoirs without considering such approximations as have just been discussed, based on factual data collected on nearby similar reservoirs.

The most difficult areas to estimate are those of reservoirs whose structures are of low relief or those that have no apparent structural features in which the limits of oil accumulation depend upon the distribution of the sands and rocks and their ability to hold oil. Such deposits are relatively scarce but when they are suspected it will be necessary to estimate as best one can the limits of the oil-bearing parts of the reservoir formations basing such estimates whenever possible on studies of similar occurrences in known fields. Even a large error in estimates of prospective areas, however, will not greatly affect the calculations of oil reserves in a region because of the comparative rarity of the abovementioned types of oilbearing reservoirs.

Determining Net Thickness of Oil-Bearing Strata

Inasmuch as oil-bearing formations seldom are uniformly porous and permeable from top to bottom but contain streaks and lenses of clay and shale that are not oil bearing, a factor is included in the equation for calculating reserves by the volumetric method to take care of the non-uniformity of reservoir sands and rocks. This factor (net thickness) must be known so that the volume V of a reservoir can be determined. The volume of the clay and shale strata in developed reservoirs can be determined from core, electric log, and geological data by plotting the information on cross-sections taken through the reservoir. Subtracting the volumes of the impervious formations from the overall volume of the reservoir gives the volume of that portion of reservoir that actually contains oil.

When calculating oil reserves in reservoirs that have not been drilled (possible and prospective oil-bearing reservoirs) the net volume of oil-bearing sands and rocks can sometimes be estimated with reasonable accuracy from a study of the outcrops, or approximated from the best data available on nearby similar-type reservoirs undergoing development.

Determining Other Factors

In the equation given in this article for the estimation of oil reserves by the volumetric method appears a factor (specific-gravity factor) for converting volumes to weight, and a porosity factor for determining the volume of the pore spaces in the reservoir sands and rocks. The introduction of the specific-gravity factor in the equation is not essential as the reserves may be expressed in units of volume. Incorporating the specific-gravity factor into the calculations introduces certain difficulties because the gravity of the oil is not the same in different oil-bearing formations in a given area, or in reservoirs in different areas. Furthermore, the specific gravity of the oil in a reservoir generally decreases with depth and the oil in the flanks of a structure has a higher specific gravity than that nearer the top of the structure. It is necessary, therefore, to make allowances for the variations in specific gravity of oil and to determine an average gravity for each given horizon or reservoir. In any case, however, the specific gravity of crude oils in oil reservoirs generally varies only between 0.84 and 0.92 and the largest value exceeds the smaller by only about 10 percent. The probable error that results, therefore, when the specific gravity of the oil is estimated and an average value is used in calculating probable and possible reserves will not greatly affect the accuracy of the reserve estimates for a region.

The coefficient of porosity of reservoir sands and rocks in developed and partly developed reservoirs is determined from laboratory tests made on core samples. For reservoirs that have not been drilled, porosity determinations may be made on samples of the formations from their outcrops or estimated from tests made on cores obtained from similar but developed reservoirs. The porosity of a sand, however, must not be confused with its permeability. By porosity is meant the capacity of a sand to hold oil; the permeability of a sand is a measure of its capacity to permit fluids to flow through it and the influence of permeability is reflected in the recovery factor. The permeability of a sand like its porosity is dependent, however, upon the shape of the pore spaces, their size, etc.

Some estimators include in their reserve calculations a factor to take care of the shrinkage of oil upon production realizing that a unit volume of

[1]Translated from the Russian Geological Journal. *Problemy Sovetskoi Geologii* (Problems of Soviet Geology) 6, 1936, pp. 34-43, 133-196, by A. A. Boehtlingk, publisher of *Foreign Petroleum Technology*, Berkeley, California.

oil may be as much as 25 percent greater in the reservoir than when it reaches the surface of the ground. As the calculations discussed in this article take into consideration, however, a recovery factor that is based on actual production data and constitutes, therefore, a ratio of the quantity of crude oil brought to the surface of the ground through wells and the total quantity of oil in the reservoir (based on the condition that all pore spaces in the permeable parts of the sand are filled with oil) no consideration of volume shrinkage of oil during its production is necessary.

Other Methods of Calculating Reserves

Methods of calculating the oil reserves of a region based on the quantity of oil produced per hectare or per acre, or on volumes—per 100 cu. m., per acre-foot, etc.—also are widely used and will therefore be discussed briefly although both are nothing more than modifications of the volumetric method that has been discussed in detail.

It is clear that the estimation of reserves in a new district based by analogy on the production from a unit area in already depleted or partly depleted areas is correct only if the formations in both areas have the same cross-section and are identical in their capacities to hold oil. Such a comparison assumes also that the recovery factor in the non-developed areas will be the same as it was found to be for the developed areas. Estimates based on the probable recovery per unit volume (per 100 cu. m. or per acre-foot), therefore, actually are a consideration of the volumetric method and the further consideration that the recovery factor will be the same in both areas. Obviously by either method of calculating oil reserves, the area of the reservoir must be known or approximated.

Fig. 3. Illustrating the relationship of the heights of the oil stratum and the reservoir

Final Figures of Reserves

In addition to the need for determining the surface areas of the different types of oil lands as indicated at the beginning of this article, the final figures of oil reserves in individual horizons or areas as a whole include a consideration of the following factors:

(1) When calculating proved oil reserves:
Initial yield of the wells and a consideration of the coefficient of production decline.

(2) When calculating semi-proved reserves:
Number of wells to be drilled; their probable initial production rate, and their coefficient of production decline.

(3) When calculating probable reserves:
The method of analogy using the same factors as determined for proved and semi-proved reserve calculations.

(4) Reserves of each reservoir as determined by the method of curves should be checked by calculations based on the volumetric method with due consideration given to the quantity of oil already produced from the reservoir and the calculated coefficient of utilization.

(5) When calculating possible and prospective reserves:
A consideration of all the factors entering into the equation for computing reserves by the volumetric method.

Conclusion

The oil reserves calculated by the methods discussed do not include the reserve that may be produced by so-called secondary methods of recovery or by mining. There are at present insufficient dependable data on the recovery factors for such methods. It also is impossible to tell at this time with any degree of accuracy what the natural characteristics of a reservoir should be for the reservoir to be adaptable to secondary-recovery methods. Especially unreliable and contradictory are the data on the percentage of recovery of oil by mining. If, therefore, in calculating reserves with a view to including therein the oil to be recovered ultimately by secondary-recovery methods, a correction should be made in the suggested coefficients of utilization to allow for the increased recovery of oil from the reservoirs.

A Common Transmission Error *by W. F. Schaphorst*

P 094.6

A COMMON error in arrangement of pulleys and belts is shown in Fig. 1. The larger pulley is the standard pulley on an electric motor. The motor is underloaded. Someone sees an opportunity to increase the load, so the smaller pulley is added. That is, the two pulleys are placed side by side on the same overhanging shaft and both belts pull against the bearing in the same direction. The total pull as indicated by the figures amounts to 1000 lb. (100 + 100 + 400 + 400).

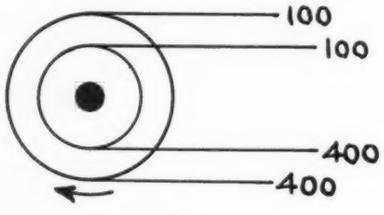


Fig. 1

This is not good engineering practice because motor bearings are designed for a definite bending force. All bearings have their limitations, of course. If the two belts leave the pulleys in the same direction as shown in Fig. 1, the design is wrong because the chances are that the bearing will not be able to withstand the combined leverage or bending moments. The outside pulley, being farther away, causes the bending stress to be greater in the bearing than that due to an equal pull on the inner pulley.

By so arranging the drives that the belts will leave in "opposite" directions, as shown in Fig. 2, the bending stress will be less than would be the case with a single pulley and with the motor pulley fully loaded. Such a condition is all right. Here we have 500 lb. acting in one direction, which is exactly balanced by 500 lb. acting the other way: (400 + 100) — (100 + 400) = 0. The belt at the left in Fig. 2 is a top pull belt, it is true, but that is better than ruining the motor for the sake of two underpull belts.

Another point to bear in mind is this: overhung pulleys on electric motors should *always* be operated as close to the bearing as possible. If you *must* run belts as shown in Fig. 1, or if you *must* place the pulley at considerable distance from the motor bearing, use an additional outboard bearing. The outboard bearing will soon pay for itself.

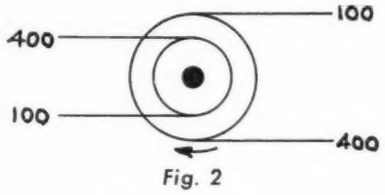


Fig. 2

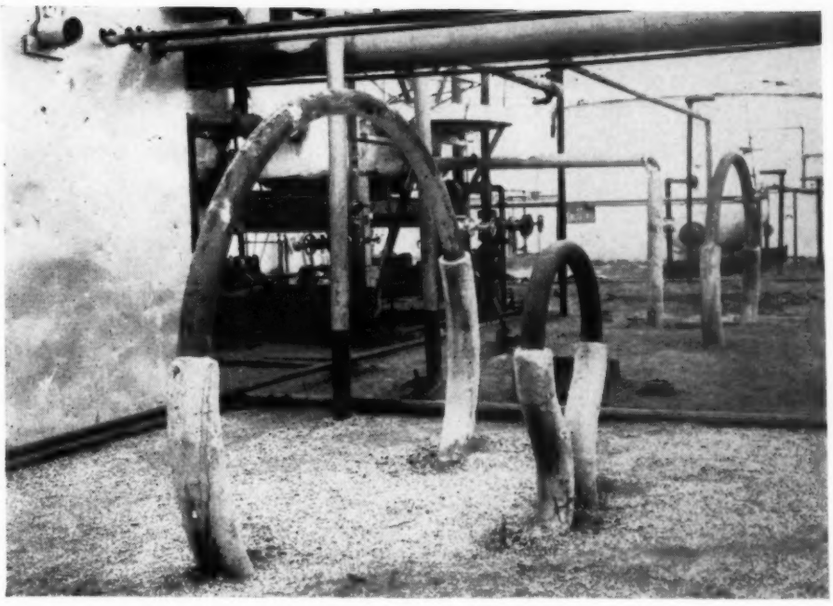


Fig. 1. Illustrating two types of bends used to dissipate expansion in hot lines

PETROLEUM ENGINEER Exclusive Feature

by

R. G. Lovell

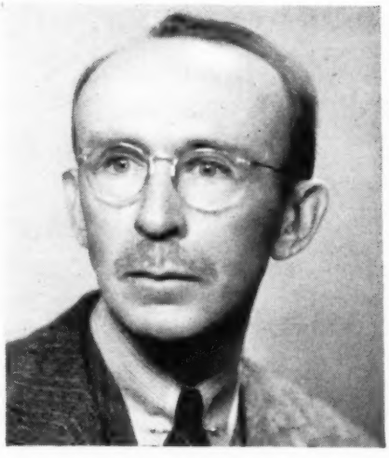
Development Engineer,
Hancock Oil Company of California

Refinery Piping — Providing for Expansion in Hot Lines

Expansion joints, pipe bends, and other methods are analyzed and discussed

THE exact amount, to the thousandth of an inch, by which steel pipe expands per ft. of length per deg. of temperature change, is of no practical importance insofar as the refinery man is concerned. On the other hand, the fact that the expansion caused by temperature is only approximately 0.001 in. per deg. of temperature rise per ft. of pipe, does not justify considering it as a negligible factor. It is often of vital importance to consider the total effect of expansion due to temperature change in a line of considerable length. It is essential to translate these considerations into terms pertaining to the specific problem in order to arrive at a satisfactory solution at a minimum cost.

Fig. 2 shows the linear expansion of steel pipe in values as accurate as are generally needed. Note that neither diameter of pipe nor thickness of its wall affect longitudinal expansion, and that the curve is not a straight line. For example, a temperature increase of 100 deg., from 200° to 300°F., causes an expansion of approximately 0.9 in. per 100 ft., but an increase from 700° to 800°F. results in an increase of 1½ in. in the same distance. This difference is not of great importance because any satisfactory method of providing for the expansion would be adequate to take care of a much wider range of temperature. Selection of method depends upon the range over which the line temperature can be expected to vary, the maximum temperature, the pressure, and the consequences that might result if a line failure occurred at any point.



R. G. LOVELL

received his academic training in New York and served several of the larger mining and milling companies of New Mexico, Arizona, and the Republic of Mexico as power engineer and master mechanic from 1908 to 1917, then saw military service in the engineering corps until 1919—Returning from the war he became affiliated with the oil refining industry, first with Standard Oil Company of California as refinery construction engineer and later with a foreign company—Later he was made assistant to the chief engineer of Pan American Petroleum and Transport Company for the construction of their California processing properties—He has been with The Hancock Oil Company of California since that time.

When the line is aboveground the provision for expansion is frequently simplified by a turn of direction, which, in itself, provides the necessary loop if the supports are designed and installed with this in mind.

In lines designed for steam or any other hot fluid, where conditions of pressure make it practicable, the "accordion" type packless joint is suitable, particularly if the total movement is to be slight. When using a turn-of-direction as a means of absorbing expansion, precautions must be taken to see that none of the bending strains occurs in fittings or in welds. The weld is, no doubt, capable of withstanding equally as much internal stress as the pipe itself, but the strains imposed by the bending action are of an entirely different nature. If the sections of the line between anchors are relatively long, or if the temperature change is over a wide range, these strains are enormous.

It is to be presumed that welded

steel flanges would be used in any high-temperature or high-pressure work; but even these cannot be expected to withstand a severe bending strain. The web of the flange and the weld itself, acting as they do as knee braces, might withstand the strain, as might also the bolts on the "outside" of the turn; but, on the "inside" of the flange, the gasket would compress slightly and, when the strain was relieved, the flange probably would leak.

In the case of a screwed fitting the weakest point is at the base of the "make-up," which is the very point requiring the greatest strength.

Bursting Stress, Creep, and Plastic Flow

Bursting stress should be understood to mean only that stress due to the pressure in the line. It is affected by the expansion of the line and the means used to take care of such expansion.

Creep and plastic flow are interrelated and affect the bursting stress in a manner and in a degree that also depend upon expansion.

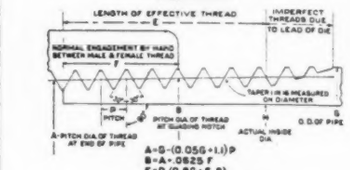
Creep, which comes as a result of plastic flow, is the tendency of a section of a line, or a tube in a heater, to increase its length when subjected to temperature rise. Plastic flow represents the actual movement of the particles of the material of which the line is composed. Plastic flow occurs both when the line temperature is increasing or decreasing.

Plastic flow and the consequent creep become manifest when the line is free to move between anchor points by deformation of the line. As the line cools, it tends to resume its original length and contour. It does not, however, contract to the original dimensions. The percentage of the restoration depends largely upon the material of which the pipe is made. If it is cast iron it has little "come-back," if of low carbon steel, somewhat more, and if of some of the better alloyed steels it will more nearly resume its original position.

Table 1

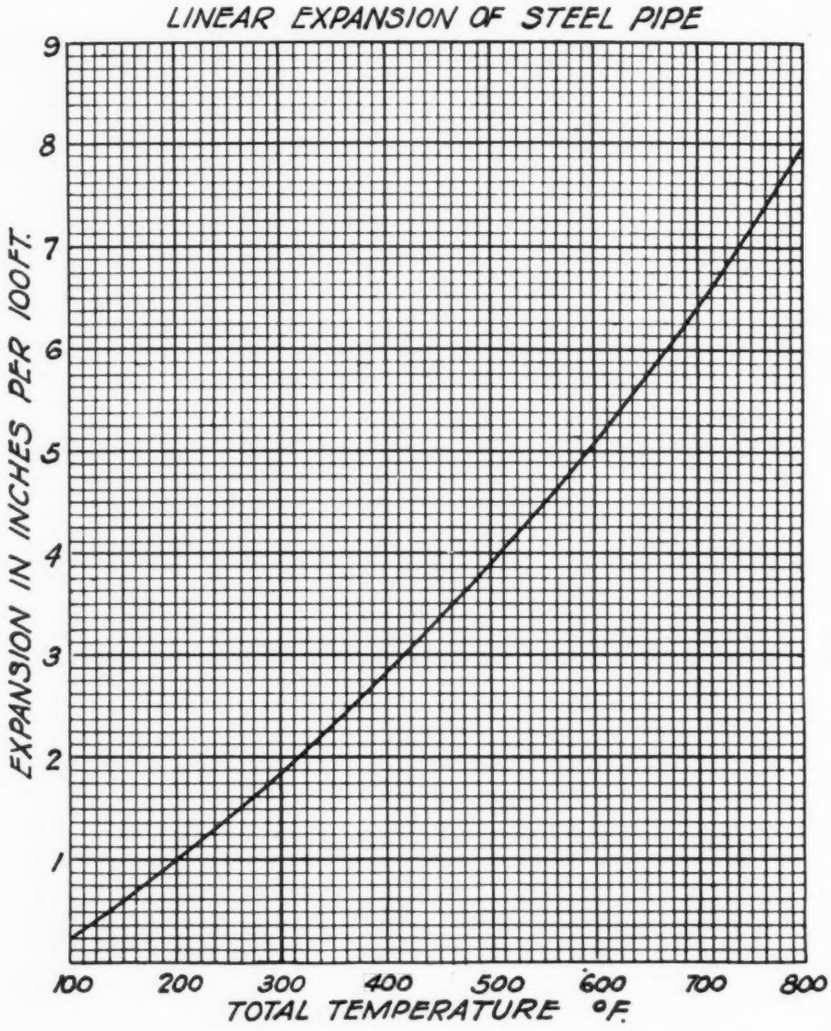
AMERICAN TAPER PIPE THREADS

(Briggs's Standard)


LENGTH OF EFFECTIVE THREAD
IMPERFECT THREADS DUE TO LEAD OF DIE
NORMAL ENGAGEMENT BY HAND BETWEEN MALE & FEMALE THREAD
TAPER 1/16 IN 16 MEASURED ON DIAMETER
PITCH
PITCH DIA OF THREAD AT GUAGING NOTCH
ACTUAL INSIDE DIA
O.D. OF PIPE
A-PITCH DIA OF THREAD AT END OF PIPE
A=G-(0.05G+1.1)P
B=A+.0625 F
E=P (0.8G+6.8)
DEPTH OF THREAD = 0.8 P

Nominal Size	A	B	E	F	G	H	Depth of Threads	Number of Threads
Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Per Inch
⅛	.36351	.37476	.2639	.180	.405	.259	.02963	27
¼	.47739	.49085	.4018	.200	.540	.364	.04444	18
⅜	.61201	.62701	.4078	.240	.675	.493	.04444	18
½	.75843	.77843	.5337	.320	.840	.622	.05714	14
¾	.96768	.98866	.5457	.339	1.050	.824	.05714	14
1	1.21363	1.23863	.6828	.400	1.315	1.049	.06956	11½
1¼	1.55713	1.58338	.7068	.420	1.660	1.380	.06956	11½
1½	1.79609	1.82234	.7235	.420	1.900	1.610	.06956	11½
2	2.29563	2.33027	.7565	.436	2.375	2.067	.06956	11½
2½	2.71963	2.78216	1.1375	.682	2.875	2.469	.10000	8
3	3.34063	3.38530	1.2000	.788	3.500	3.068	.10000	8
3½	3.83786	3.88881	1.2500	.821	4.000	3.548	.10000	8
4	4.33438	4.38713	1.3000	.844	4.500	4.026	.10000	8
4½	4.83125	4.88594	1.3500	.875	5.000	4.506	.10000	8
5	5.32975	5.44829	1.4063	.907	5.563	5.047	.10000	8
6	6.46589	6.56697	1.5125	.958	6.625	6.065	.10000	8
7	7.43994	7.60254	1.6125	1.000	7.625	7.023	.10000	8
8	8.43859	8.60969	1.7125	1.063	8.625	7.981	.10000	8
9	9.42734	9.69797	1.8125	1.130	9.625	8.941	.10000	8
10	10.54531	10.82094	1.9250	1.210	10.750	10.020	.10000	8
12	12.68281	12.91781	2.1250	1.390	12.750	12.000	.10000	8
14 O.D.	13.77500	13.97265	2.250	1.562	14.000	.....	.10000	8
15 O.D.	14.78978	14.97419	2.350	1.687	15.000	.....	.10000	8
16 O.D.	15.78250	15.97578	2.450	1.812	16.000	.....	.10000	8
18 O.D.	17.75000	17.97500	2.650	2.000	18.000	.....	.10000	8
20 O.D.	19.72750	19.97031	2.800	2.125	20.000	.....	.10000	8
22 O.D.	21.72500	21.96562	3.000	2.250	22.000	.....	.10000	8
24 O.D.	23.71250	23.96094	3.250	2.375	24.000	.....	.10000	8

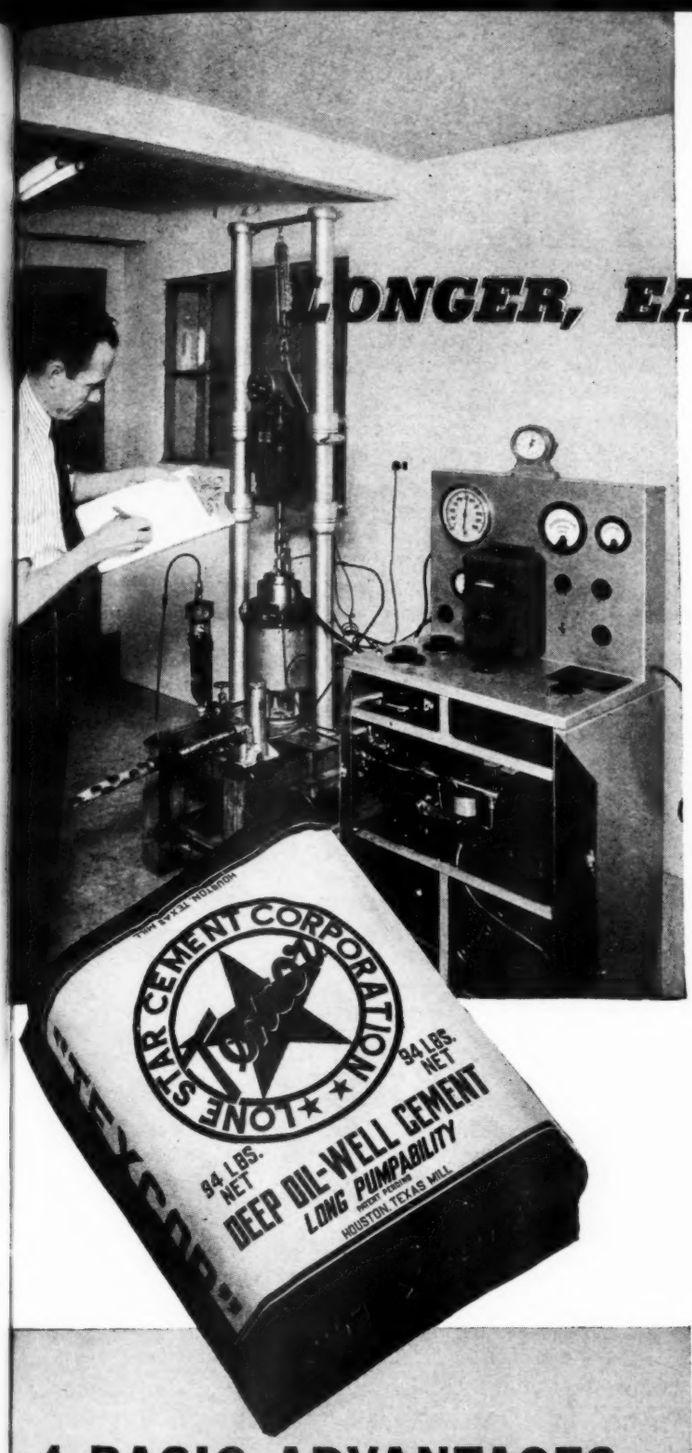
Fig. 2. Linear expansion of pipe at elevated temperatures
(Based on zero expansion at 70° F.)



On the other hand, if the line is laid underground in compact earth for considerable distances and the bearing stress of the earth is relieved only where expansion joints, or bends, are provided, a different conception is required. The theory, as commonly understood, fails to cover certain manifestations that many of us have observed. When the theory fails to hold-up in practice, therefore, the obvious thing to do is to adhere to the practical. It will, however, clarify the argument if we develop a new theory to justify the practice.

Assume a 6-in. line, 500 ft. long, covered by 3 ft. of compacted earth, with an expansion joint in the center. The line is to be subjected to temperature change from 70° to 700°F. and it is anchored at both ends. Consultation of graphs indicates that the total expansion of the line is 25 in., or 12.5 in. in each section. Does anyone suppose that a 6-in. line is going to move more than 1 ft. through compacted earth? How, then, shall we account for the fact, which the writer has observed many times, that at the expansion joint, there is a measurable movement of the line that amounts to a considerable part of the calculated movement for the temperature and distance conditions existing? It has further been observed that the actual movement of the short section of the line that is free to move inside the manhole or, in the case of an expansion loop, in the loop itself above the ground, has been greater, for equal temperature conditions,

LONGER, EASIER PUMPABILITY



AT HIGH TEMPERATURES AND PRESSURES

GREATER DENSITY, HIGHER STRENGTH, TOO

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16½-lb. 'Texcor' slurries (40% mixing water) stay pumpable for over 8 hours, at 200° F. . . . a greater safety factor than ever before. And, far from sacrificing strength for pumpability, these 'Texcor' slurries produce over 5000 lbs. in 24 hours, over 6000 lbs. in 48 hours, at 200° F.

Lower initial viscosity, greater ease of pumpability in heavy slurries, low pump pressures—greater density, higher strength in hardened cement.

CHOOSE FROM 4 GREAT CEMENTS

One of four high-quality cements for oil-industry service. Use 'Texcor'† for deepest wells, highest temperatures and pressures . . . 'Starcor'* for deep wells . . . 'Incor'* for wells of moderate depth . . . Lone Star for all-around oil-field service. The extra margin of quality means a lot.

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LONE STAR SYMBOL OF QUALITY SINCE 1900

4 BASIC ADVANTAGES

1. *Longer pumpability:* In excess of 8 hours, with 40% water (16½-lb. slurry), at 200° F.
2. *Higher strength:* Over 5000 lbs. in 24 hours, over 6000 lbs. in 48 hours, with 16½-lb. slurries, at 200° F.
3. *Lower initial viscosity:* Easier pumpability in heavy slurries . . . low pump pressures.
4. *Greater density:* Saw a 'Texcor' cube in half—notice its denser structure. Greater density, higher strength . . . longer lasting shut-offs!

...Keeping pace with Oil-Industry Progress

LONE STAR CEMENT CORPORATION

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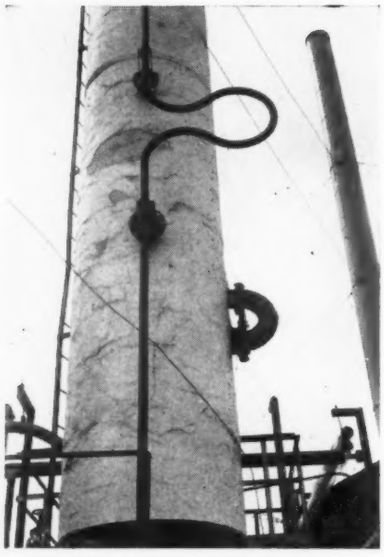


Fig. 3. An effective method of providing for expansion in hot reflux lines

when the pipe is of liberal wall thickness.

The plastic flow set up by temperature is, of course, effective circumferentially, as well as longitudinally. It is not measurable in the form of pipe distortion because it is not cumulative. The same forces tending to elongate the pipe, by plastic flow, are, at the same time tending to increase its circumference. The latter force is acting to restrain the first.

In the case of the pipe line buried in tight earth, and restrained from increasing its length as its temperature increases, a series of infinitesimal concentric wrinkles are formed around the pipe. These are so small as to be incapable of measurement, but are successful, nevertheless, in absorbing some of the strain.

Anchored Line

Fig. 4 shows how this accordion action works out when a block valve is required in a line, but an expansion joint or a loop is not used. Some provision must, of course, be made to prevent plastic flow from causing creep in those parts of the line immediately adjacent to the valve. Such creep must, inevitably, be absorbed by the valve body, which, if it is of heavy steel, might withstand the strain without rupture, but the free operation and tight closure of the valve are very likely to be affected by the distortion of the disk guides with respect to the disk itself. In passing, it should be noted that this tends to indicate the advantage of the high-pressure, lubricated plug cock for such service. The opening in which the plug revolves, being round, is better able to withstand the strain without interfering with the proper functioning of the valve.

The duty of the concrete anchors is a double one. They resist the creep and, because the concrete is more dense and stronger than earth, the wrinkle action is confined to the main body of the line, thus relieving the sections in the valve box from these strains.

When a good type of expansion joint is used, the concrete anchors are unnecessary. Other types of joints, which depend upon packing, are not generally considered satisfactory for the severe duty imposed by wide temperature changes, or where leakage sets up fire hazard, or potential loss of stocks.

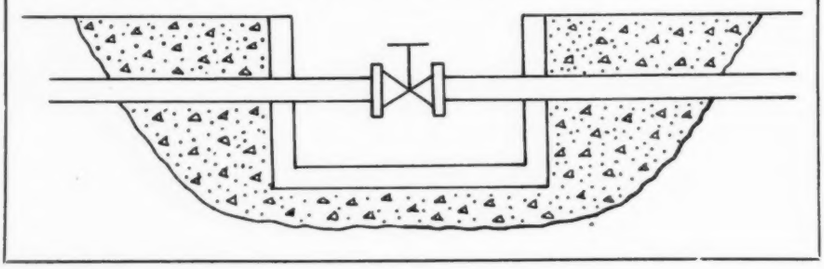
Threaded Joints

The statement has been made that threaded connections are to be avoided whenever possible. In many cases, however, welded connections cannot be used; it is advisable, therefore, to determine what can be done to remove some of the objections to threaded joints.

Considering the strains imposed by bending stress, the weakest point is at the base of the made-up joint. It is weakest because of the amount of material that has been removed from the pipe wall in cutting a full depth thread. All the strain of bending, then, occurs at the place least fitted to withstand it.

Much can be done to improve this condition by cutting threads of the proper length. The tendency has always been been to cut threads too long, apparently with the idea that the joint was bettered thereby, which is definitely erroneous. Table 1 will be found convenient for determining proper thread specifications. Consideration should be given to the length of die

Fig. 4. Valve protected from expansion stresses by adjacent concrete anchors



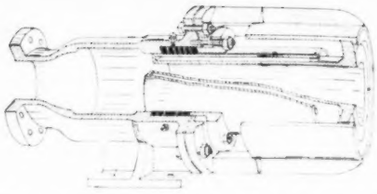


Fig. 5. Showing essential features of a duplex sleeve expansion joint

being used. Virtually all hand dies have the same depth for each size range, but in the conventional pipe machine the dies are somewhat deeper. A little study of the table and references to the dies in use will clarify this matter.

Even when this lesson has been learned, some believe that the reason the long thread caused a leaking joint was that the end of the pipe came to a stop at a shoulder in the fitting before make-up was complete. This is seldom the real reason. The actual fact usually is that the full threads on the pipe end engaged, and were brought to a stop, by the imperfect or shallow threads at the base of the fitting tapping, while full threads were still engaging full threads at the end of the fitting and, consequently, there was not metal-to-metal contact at the base of these threads.

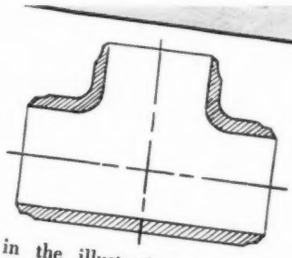
An actual experience of the writer will serve to add force to this point. He was engaged at the time, some years ago, in rebuilding and modernizing a straight-run refinery of 3500 bbl. per day capacity. Circumstances were such that re-use of pipe and fittings was desired. The fittings were standard malleable—not the modern oil malleable—and it was reasonable to assume that they had been deformed in first make-up, and that this deformation had become permanent by reason of time and temperature.

The fitters were instructed to cut-off all old threads and were given the proper lengths of threads to be used for each size. When the job was ready for a test run, a multitude of leaks were expected, many more than would be expected had the job been done with new pipe and fittings, but no leaks were detected.

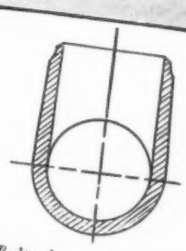
Use of Thread Compound

There is only one reason to use any dope on pipe threads, and this is in order to lubricate the rough surfaces left by the thread cutting so that the joint will make-up tightly without the heat of friction causing the metal to expand and leave the joint loose when cold. The idea that the pipe dope can safely compensate for lack of tight metal-to-metal contact is altogether fallacious. A small amount on the first few threads on the male end is sufficient.

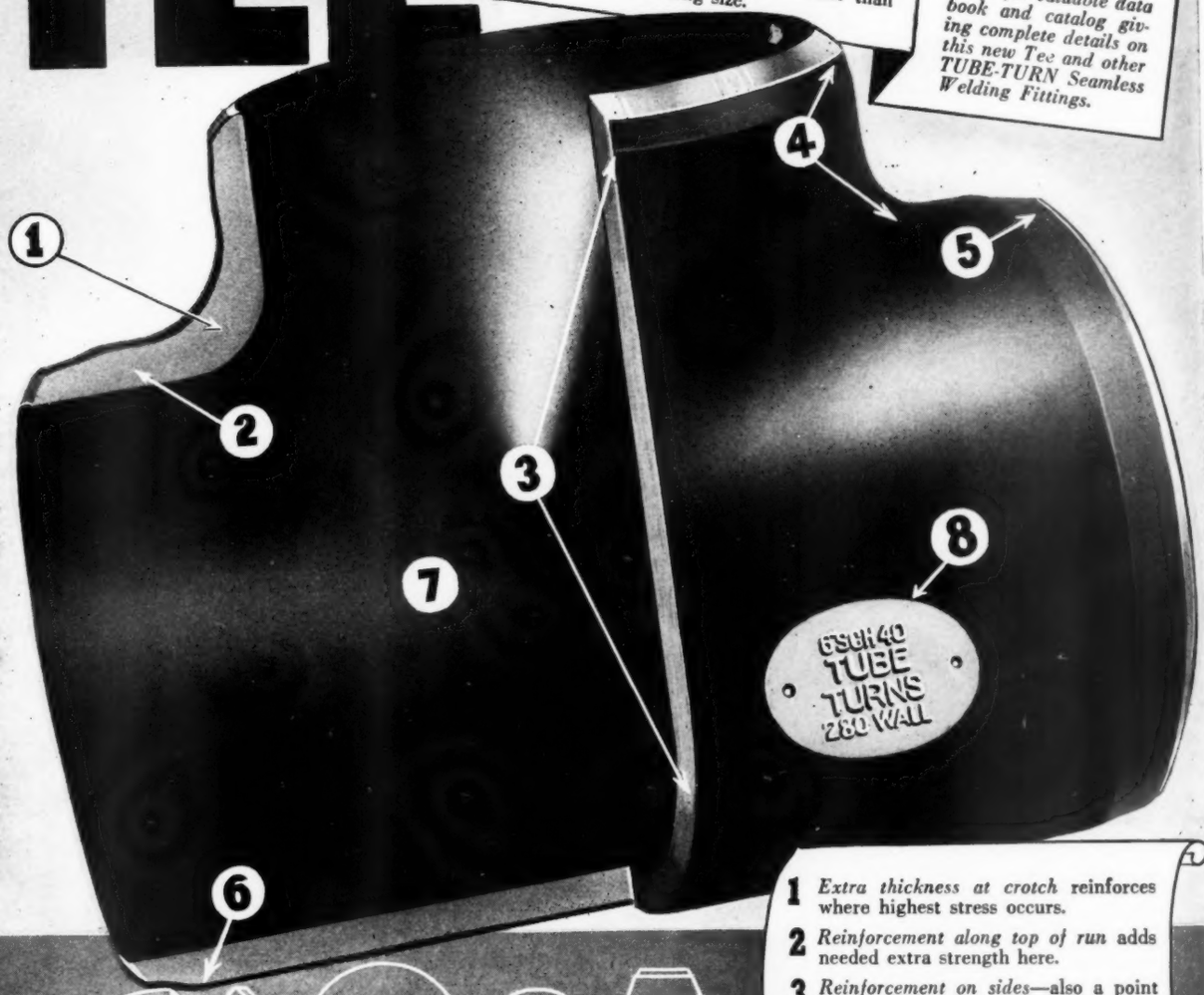
8 reasons for specifying TUBE-TURN Welding TEE



Note in the illustrations here how the reinforcement is placed at *all* points of higher-than-normal stress. Numerous bursting-pressure tests prove that TUBE-TURN Tees will withstand higher pressures than pipe of corresponding size.



Write for valuable data book and catalog giving complete details on this new Tee and other TUBE-TURN Seamless Welding Fittings.



1 *Extra thickness at crotch* reinforces where highest stress occurs.

2 *Reinforcement along top of run* adds needed extra strength here.

3 *Reinforcement on sides*—also a point of high stress gradually tapers toward end of outlet and bottom of run.

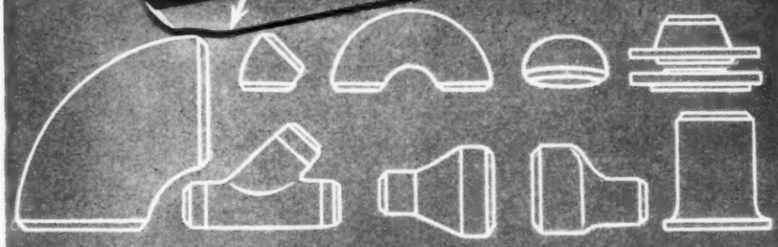
4 *Longer outlet* permits faster lining up and ample room for rod manipulation.

5 *Ends machined* to exact pipe wall thickness—easy to align and weld.

6 *Increased thickness at bottom* adds to full strength without excess weight.

7 *Smooth inside walls, curved inner crotch and special manufacturing process* assure even flow.

8 *Size, material, thickness and name* identified on permanent name-plate.



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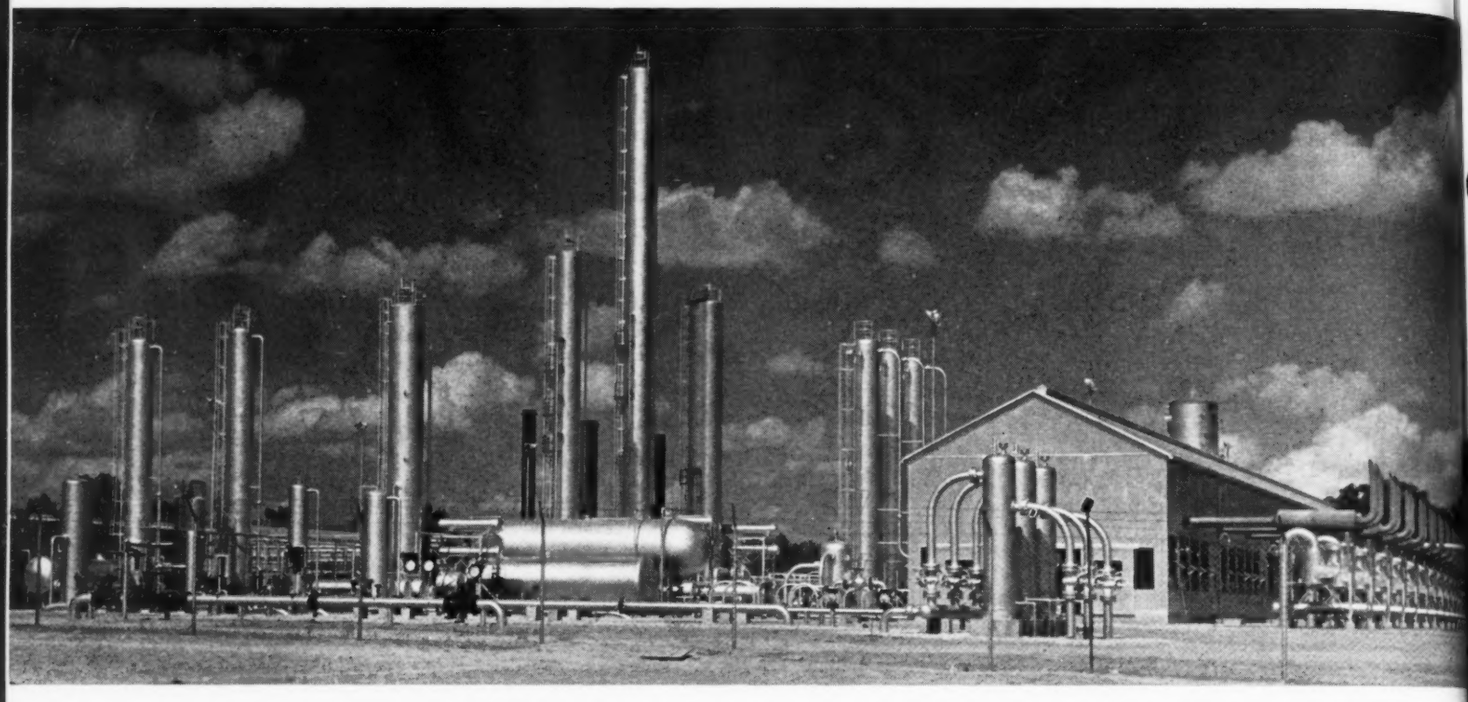
Cotton Valley Cycling and Pressure-Maintenance Project

P 773.1
P 537.



A general view of plant showing processing area on left and compressor building on right

by Frank H. Love
Managing Editor

Exclusive

Plant designed for throughput of 150,000,000 cu. ft. of gas per day; 135,000,000 cu. ft. returned to producing zones at pressure of 2750-2900 lb.—Absorption system operated at 1500-lb. pressure

THE Cotton Valley cycling and pressure maintenance plant, in the Cotton Valley field, Webster Parish, Louisiana, the culmination of one of the outstanding conservation and unitization achievements in the Mid-Continent area, was formally dedicated at an all-day barbecue and ceremony on July 10. Governor Sam Houston Jones of Louisiana was the principal speaker and other prominent state officials were present, including Joseph L. McHugh, director of the Department of Minerals, and George A. Wilson, attorney for the Department of Minerals. Major B. A. Hardey, chairman of the Board of Minerals, could not be present but wired his best wishes.

The Cotton Valley Unitization and Pressure-Maintenance Project was developed by a group of operators who banded together and formed the Cotton Valley Operators Committee, which is composed of representatives of the companies operating in the Cotton Valley field. The Operators Committee was assisted in its work by various subcommittees, such as the engineering committee, the legal committee, the land committee, and the accounting committee. The personnel of these committees was made up of department men of the various companies represented. There was set-up by the Operators Committee a separate and independent organization for the operation of the field and an Advisory Committee of four members from the Operators Committee for the purpose of advising and counseling with the general manager in the operation of the field. The members of the Advisory Committee are J. J. Frommer, Ohio Oil Company, chairman; W. F. Dalton, Hunt Oil Company; Roy Davis, North American Oil Consolidated, and Howard Davenport, Woodley Petroleum Company. J. R. Butler is general manager of the Cotton Valley Operators Committee.

The entire condensate zone comprising 12,590 acres in the Bodcaw sand and 10,600 acres in the "D" sand has been unitized as regards all formations below the base of the Travis Peak, under the terms of the Cotton Valley Unitization and Pressure Maintenance Agreement participated in by 25 operators, independents and majors, and more than 600 land owners and royalty owners. The participating operators are: Hunt Oil Company, The Ohio Oil Company, Oliphant Oil Corporation, North American Oil Consolidated, Woodley Petroleum Company, Magnolia Petroleum Company, Stanolind Oil and Gas Company, Superior Oil Corporation, Union Producing Company, Fohs Oil Company, H. L. Hunt, Root Petroleum Company, J. B. Atkins, W. A. Delaney, Jr., Hassie Hunt, Jabco, Inc., M. H. Marr, Mrs. Nellie Myers, S. G. Myers, W. G. Ray Drilling Company, Inc., Dr. I. B. Rougon and Mrs. Annie Laurie Rou-

COTTON VALLEY OPERATORS COMMITTEE AND HUDSON ENGINEERING COMPANY

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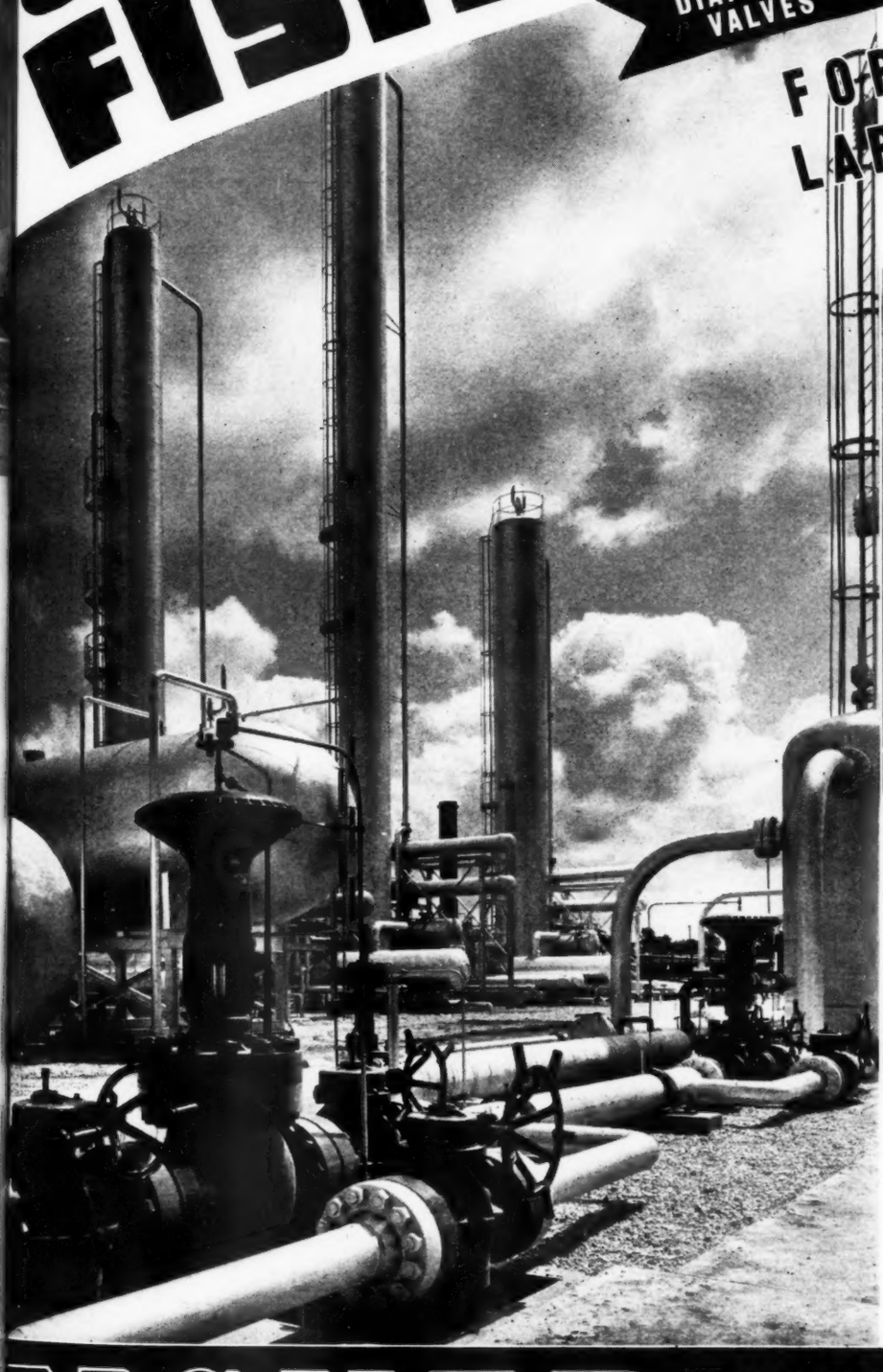
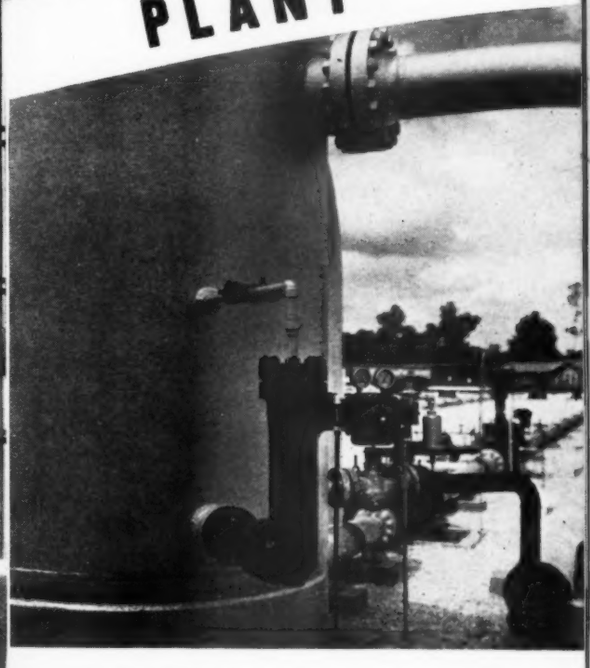
DIAPHRAGM VALVES ★ PRESSURE REGULATORS ★ LIQUID LEVEL CONTROLLERS

FOR THE WORLDS LARGEST RECYCLING PLANT





The 8" Type 57T Diaphragm Control Valve with Series 1500 lb. cast steel body, seen in the foreground at left, is the largest of its kind ever built. It is the emergency shut-off valve for the entire plant, and is actuated by any one of three different controls as follows:

1. By a Fisher Level-Trol, shown above, in the event the maximum level in the accumulator is exceeded.
2. By a Fisher Wizard Pilot Controller should the upstream main line pressure fall below the minimum requirement or fail entirely.
3. By a solenoid valve actuated by a switch in any one of several emergency stations throughout the plant.

The 6" Type 57T Diaphragm Valve, also with Series 1500 lb. cast steel body seen in the background at left, is the primary pressure reducing valve in the main supply line to the plant.

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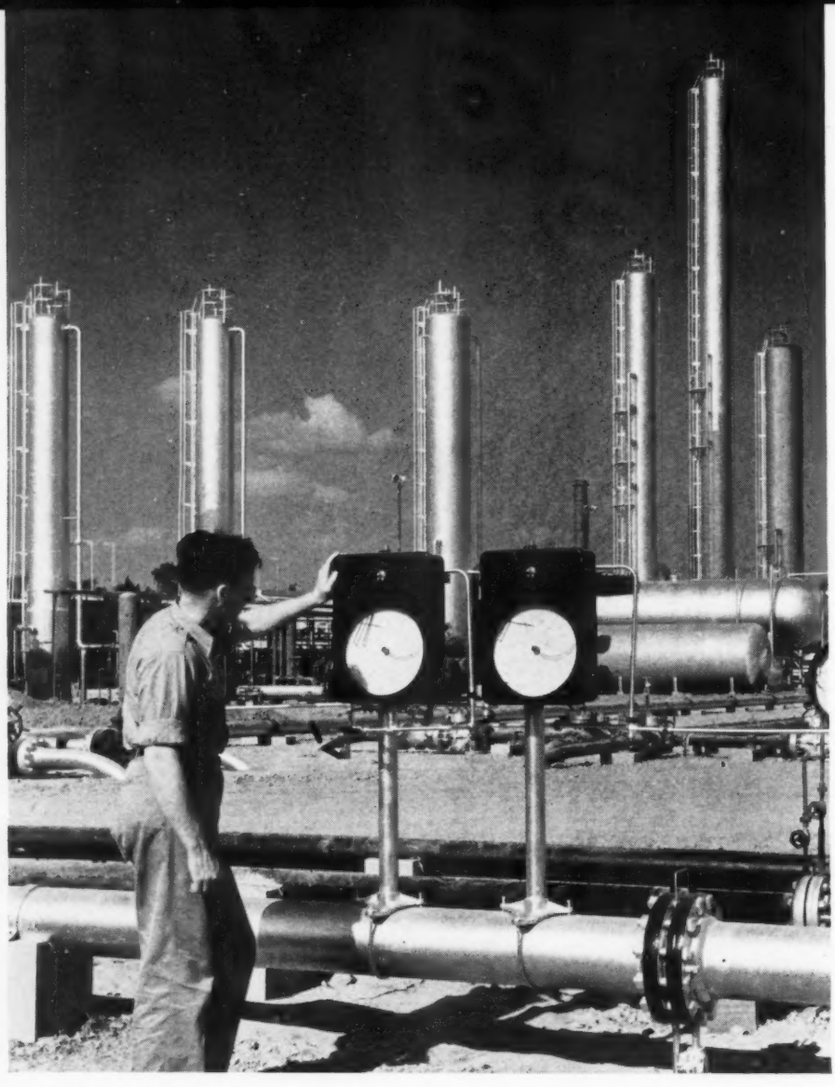


All gas measurements in the plant are made with differential recording meters of the type shown

gon, E. L. Stewart et al., G. H. Vaughn, Welori Lumber Corporation, and W. C. Woolf.

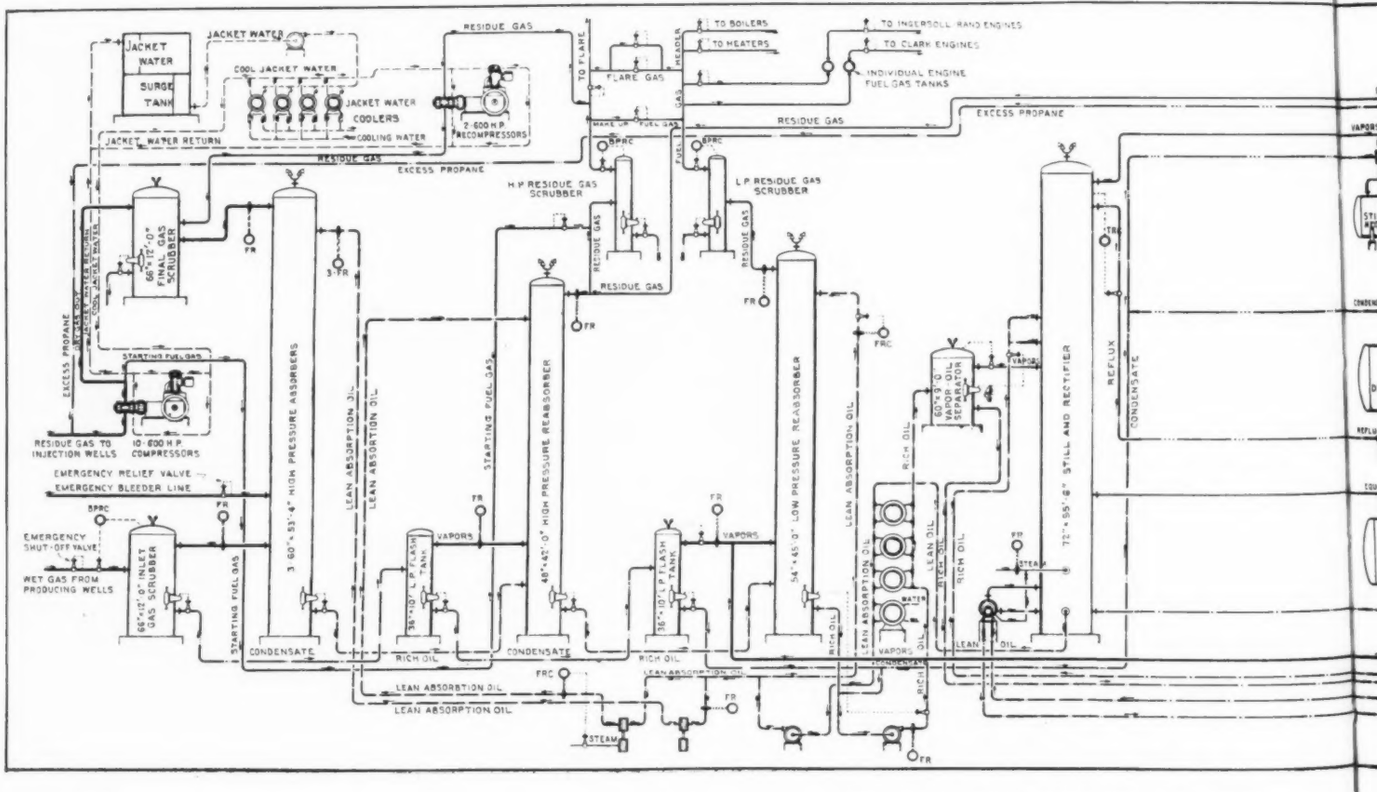
The plant, the construction of which cost in excess of $2,250,000, is designed for a gas throughput of 150,000,000 cu. ft. per day. When operating at capacity, condensate production will be approximately 10,000 bbl. per day and more than 500 bbl. of *iso*-butane per day. Of this gas volume, approximately 135,000,000 cu. ft. per day is returned to the "D" and Bodcaw formations through 2 and 5 injection wells, respectively.

Condensate production is from wells in the Bodcaw and "D" sands found at a depth greater than 7900 ft. Gas-condensate ratios were approximately 13,000 to 1 at discovery and now average about 17,000 to 1. The gas-condensate area is encircled by a rim of oil wells, located outside the Bodcaw and "D" sand participating areas, producing with gas-oil ratios varying from 2000 to 1 upward. One of the principal conservation features of this operation is the handling in the plant of the gas produced with the rim oil, utilizing this gas for gas sales. The demand previously was supplied from the condensate area with the excess gas from the rim wells being vented.

Gathering System

To gather production from the gas-condensate wells the field is circled with approximately 11 miles of 6-in.

Flow diagram of Cotton Valley cycling plant



O.D. line, from which four main lines extend to the plant. These lines consist of about 2 miles of 6⅝-in. and 3.25 miles of 8⅝-in. pipe. All are 2200-lb. working pressure and 4000-lb. test. Lateral lines to the wells are of 2⅜-in. and 4½-in. pipe.

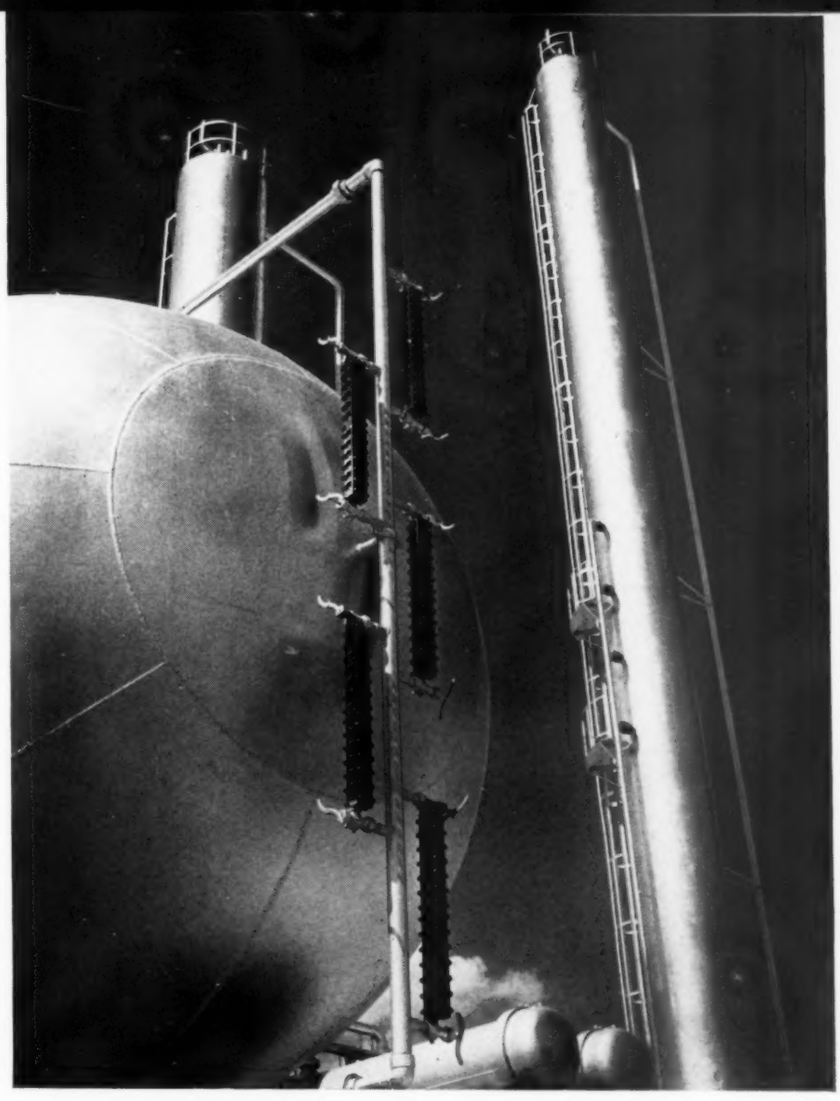
To gather gas produced by the rim oil wells, the field is partly circled by a line consisting of 4½-, 6⅝-, and 8⅝-in. pipe, with a total of 18 miles. From this line three main 8⅝-in. lines extend to the plant. Lateral lines to tank batteries, where the gas is taken from field separators, are of 4½-in. screw pipe.

At the junctions where the lines to the plant connect with the line circling the field, which serves as a sort of header, 3-valve manifolds are installed. On the high-pressure system the valves are of a gear-operated plug type. On the low-pressure system the valves are of the plug type but not equipped for gear operation.

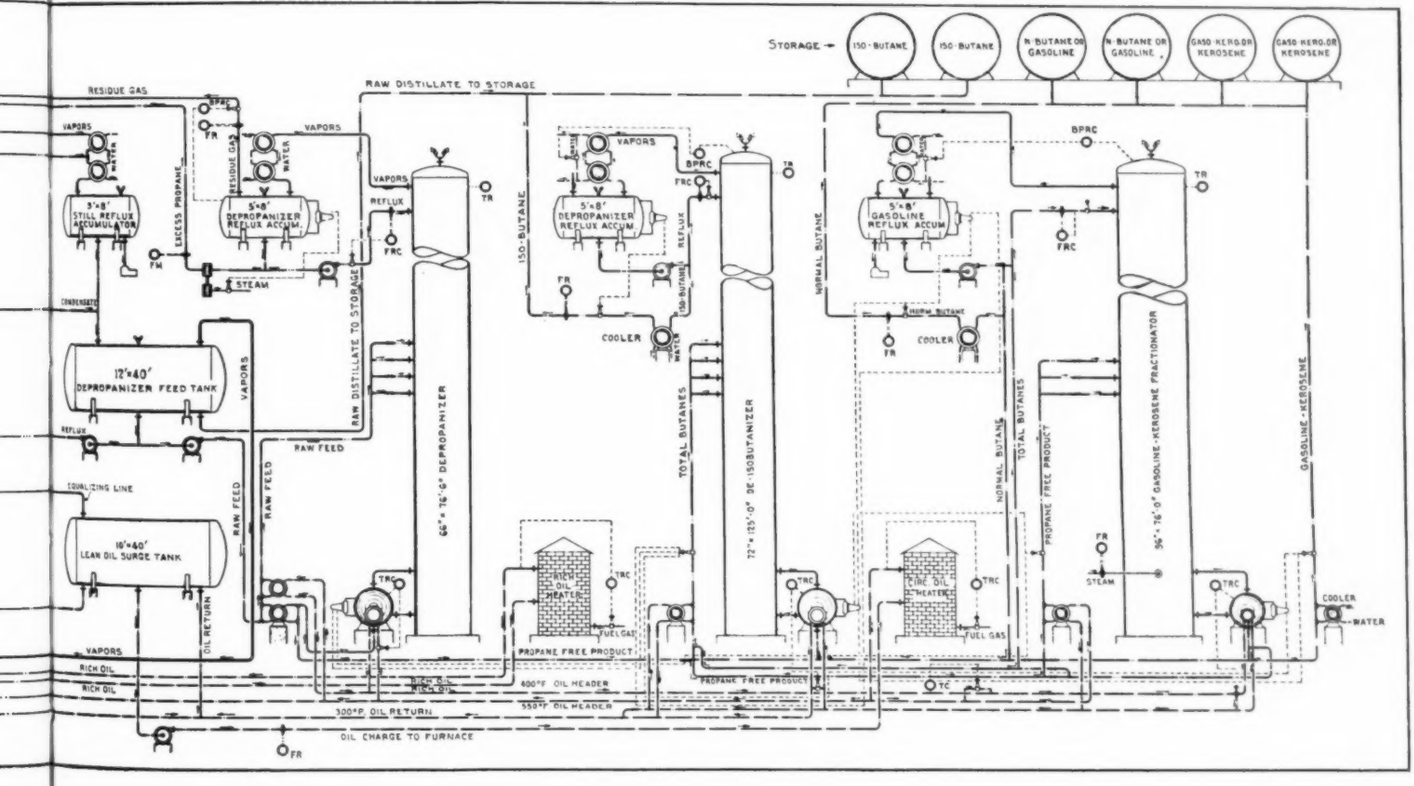
Gas Cycle

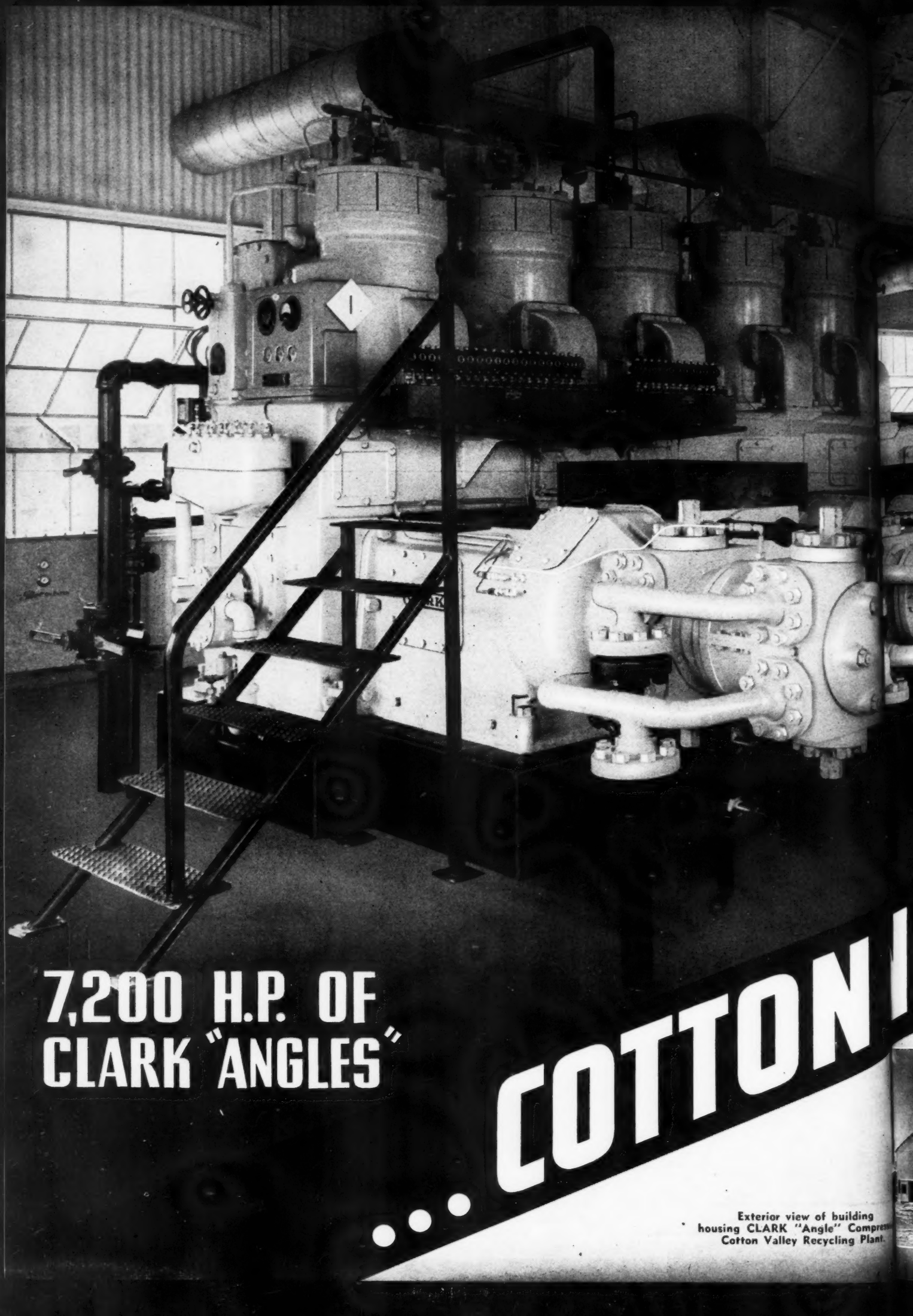
As the gas arrives at the plant through four inlet lines, it enters a common 10-in. line and before passing to the inlet scrubber is reduced from 1800 lb. to 1500 lb. by a diaphragm motor valve. Two valves of this type are installed on the main intake line, one functioning as the primary pressure reducing valve and the other as a safety shut-off valve. From the inlet

(Continued on Page 38)



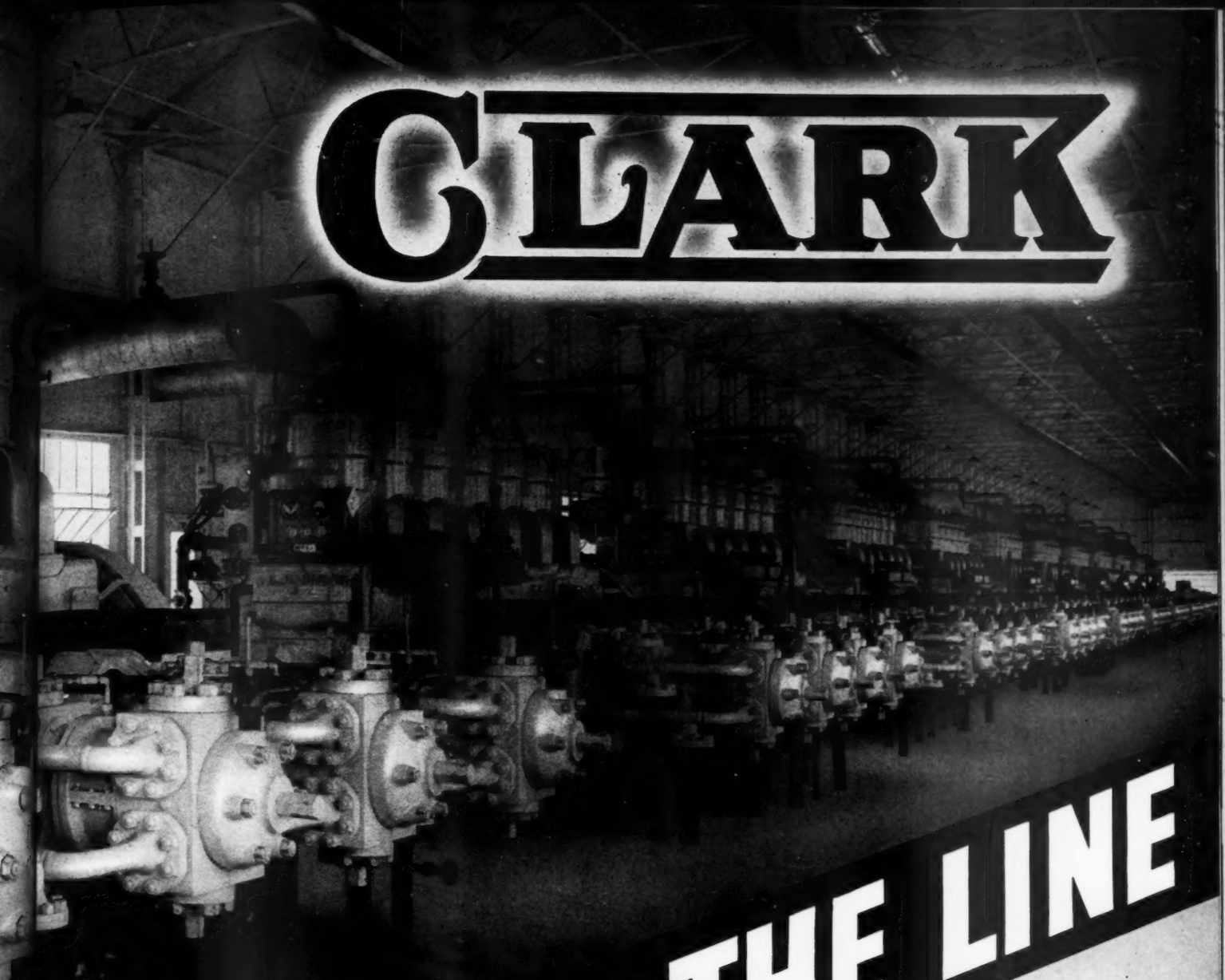
Liquid level gauges on depropanizer feed tank



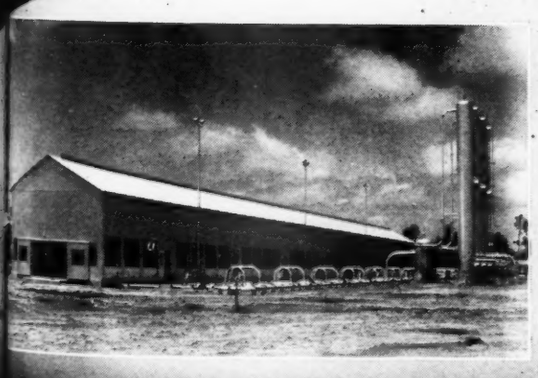


Exterior view of building
housing CLARK "Angle" Compres
Cotton Valley Recycling Plant.

CLARK



VALLEY-ON THE LINE



The Cotton Valley Recycling Plant, just completed at Cotton Valley, Louisiana, provides an outstanding example of effective cooperative effort in gas conservation. The Cotton Valley Field is a major reserve of the gas condensate type, the reservoir having been originally estimated at 526 billion cubic feet of high-pressure gas containing 47,000,000 barrels of condensable carbons. The new recycling plant serves the project confined to sands below top of Cotton Valley formation, having been constructed by a cooperating group of 30 operators and 600 royalty owners.

The plant is designed to handle 150,000,000 cu. ft. of gas daily. Gas is taken from 69 condensate wells, reaches the inlet gas scrubbers at pressures averaging 1,500 lbs., and is returned to the sand through ten injection wells at a pressure of 3,200 lbs. The plant can produce daily 13,300 bbls. of natural gasolines, 2,500 bbls. of butanes, 2,400 bbls. of kerosene, and 650 bbls. of isopentane. High-pressure absorption is used to extract the liquid fractions of the gas, and the most advanced recycling practices are employed.

The compressor battery consists of twelve 600 H. P. CLARK "Angles." Ten of these compress the gas and return it to the sand at 3,200 lbs. pressure. These units are equipped with forged steel compressor cylinders and are arranged so the plant can obtain maximum flexibility under a wide range of conditions. The other two compressors operate on recompressor vapors at pressures from 350 to 1,500 lbs. and are equipped with cast steel compressor cylinders.

The Cotton Valley project represents an important new chapter in the conservation of natural reserves and is thus a basic contribution to the program of national defense. Clark wishes to compliment the Cotton Valley operators and royalty holders on this splendid cooperative achievement.

CLARK engineers are experienced in every phase of oil industry engineering having to do with recycling and pressure maintenance. Their expert knowledge and advice are yours for the asking. Get in touch with our nearest office.

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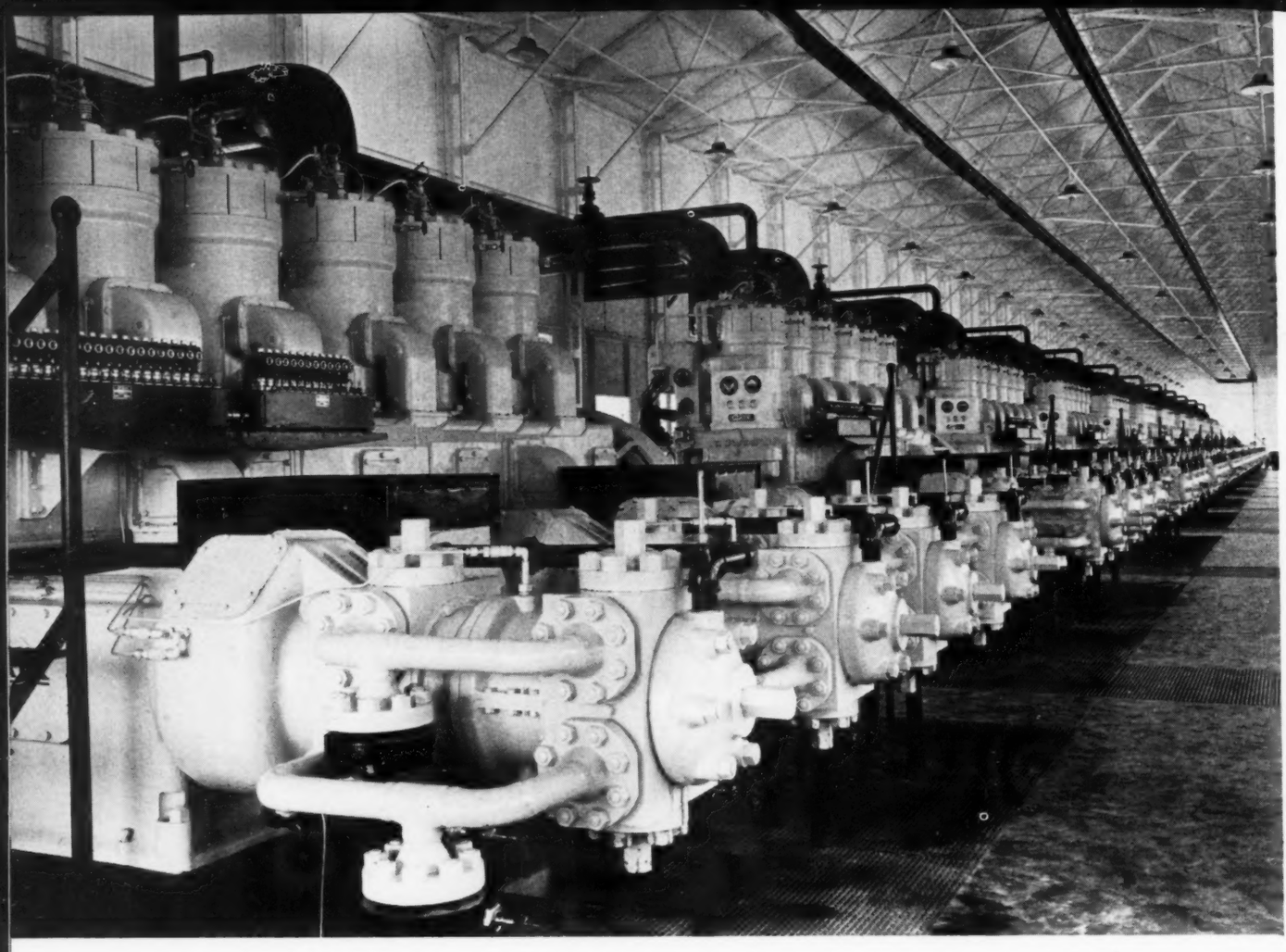
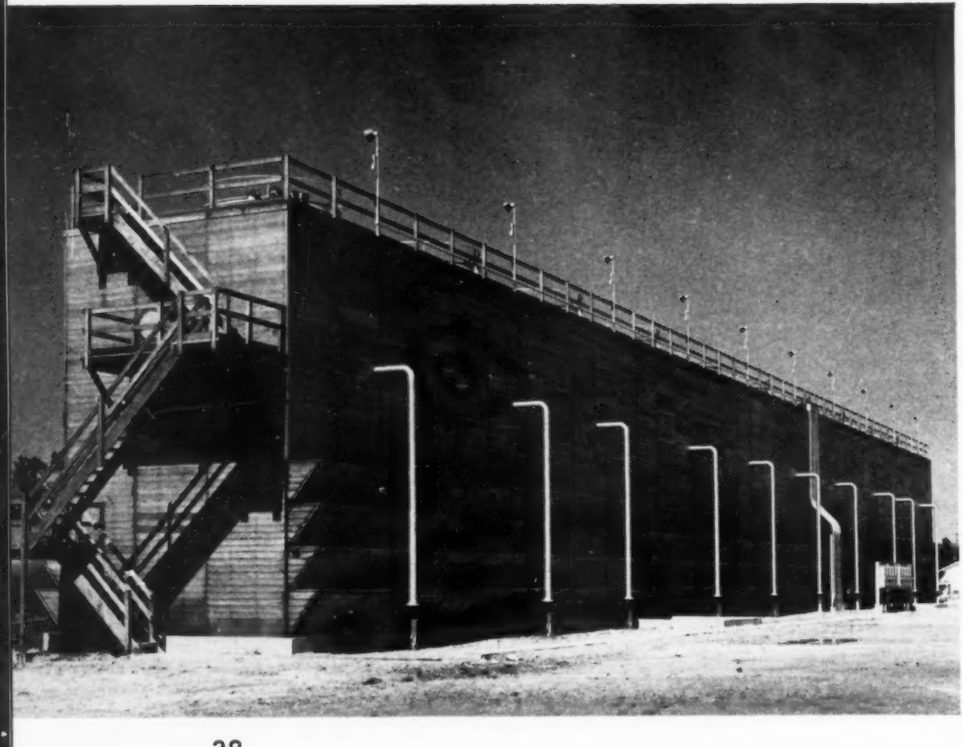


Compressors consist of twelve 600-hp., angle-type units, ten of which are used for cycling and two for recompressor service

The cooling tower is of the induced draft type and has a capacity of 4650 gal. per min.



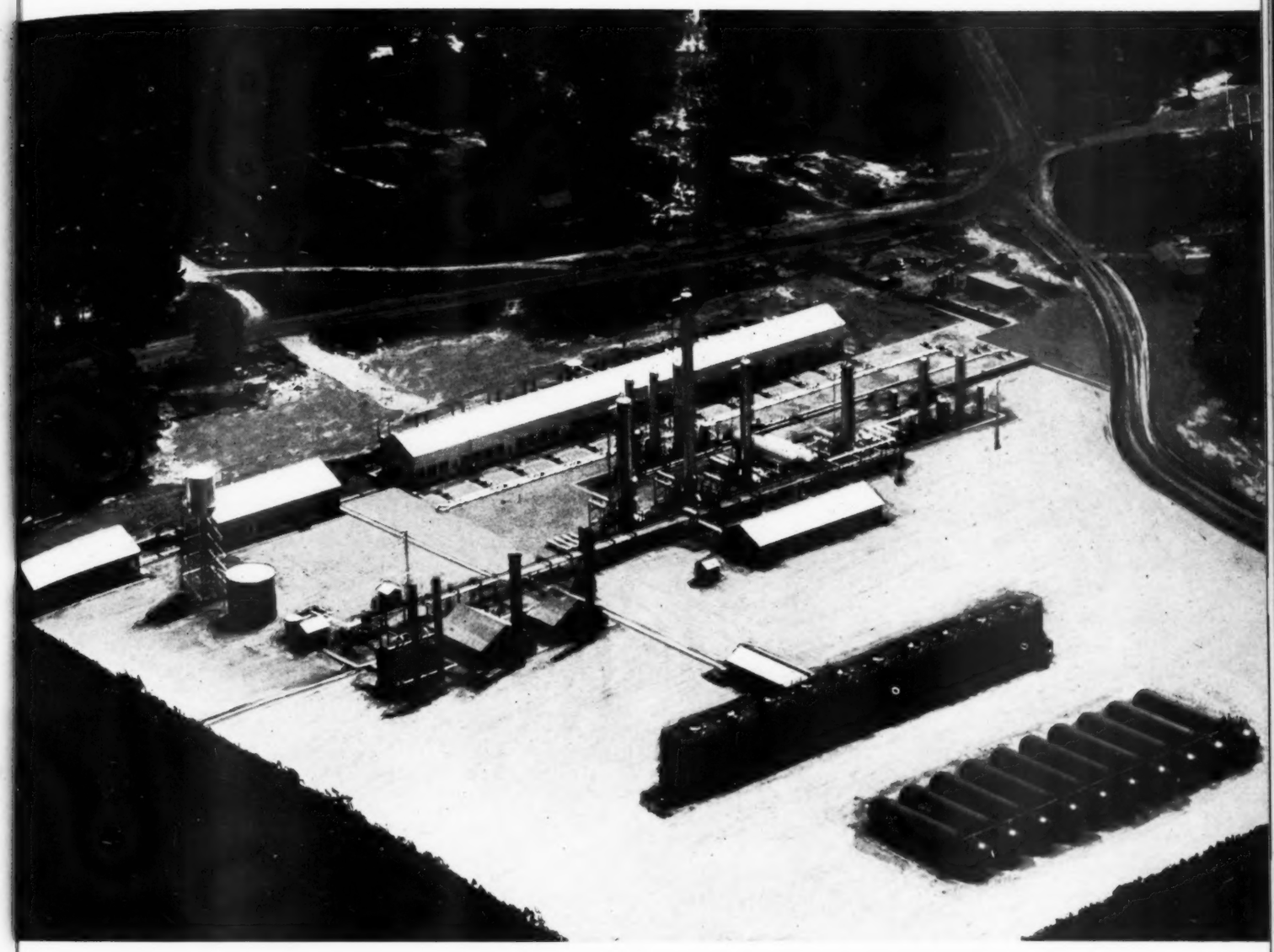
(Continued from Page 35)

scrubber, which is 5 ft. 6 in. I.D. by 12 ft. high, the gas is discharged into a 10-in. header, thence to three high-pressure absorbers. These absorbers are of 5 ft. I.D. by 53 ft. 4 in. high, have a 3-in. wall thickness, and a test pressure of 3000 lb. The working pressure is 1500 lb. and the operating temperature between 80°F. and 90°F. Upon leaving the high-pressure absorbers the gas enters the outlet scrubber, which is 5 ft. 6 in. in diameter and 12 ft. high, being discharged to a 10-in. header from which the 600-hp. compressors take suction at a pressure of 1500 lb. Compression is by single stage. Discharge headers are of 8-in. pipe, and lines extending from these headers to injection wells are of 6⅝-in. Gas to be returned to the "D" sand is discharged from the compressors at a pressure of 2800 to 2900 lb. per sq. in.; discharge to the Bodcaw sand is at a pressure of 2750-2800 lb. Approximately 75 percent of the gas is being injected into the Bodcaw sand and 25 percent to the "D" sand.

Processing

Condensate from the inlet scrubber is heated to a temperature of 90°F. before passing to the high-pressure flash tank, which is 3 ft. in diameter and holes in the shaft to the crank-pin bearings, and thence through drilled

Cotton Valley Plant



BRINGS TOTAL CAPACITY OF HUDSON DESIGNED PLANTS TO OVER 700 MILLION CUBIC FEET DAILY

The Cotton Valley Plant, designed and constructed for the Cotton Valley Operators Committee, is one of the numerous oil and gas processing plants completed by Hudson Engineering Corporation in recent months.

Having a daily capacity of 150,000,000 cubic feet, this plant is designed to recover distillate from the extremely rich gases produced from the sands of the Cotton Valley field; to fractionate the recovered distillate into an ethane-propane mixture, iso-butane, normal butane, and butane free distillate; and to return the dry gases to the producing sands.

* * * *

Hudson offers the services of an integrated engineering and construction organization, specializing in the design and complete construction of: Refinery Process Plants, Gas Compressor Stations, Oil Pipe Line Pumping Stations, Gas Line Absorption Plants, Distillate Recovery Plants, Fractionation Units, Dehydration Plants, Natural Gasoline Plants, Desulphurization Plants, and Mechanical Draft and Natural Draft Cooling Towers.

Hudson

HUDSON ENGINEERING CORPORATION • Fairview Station • Houston, Texas

Compressor suction and discharge lines and high-pressure valves controlling gas flow

10 ft. high, and operates at a pressure of 375 lb. The condensate passes to the low-pressure flash tank, operated at 110-lb. pressure and 90°F. temperature. Vapors from the high-pressure flash tank are discharged to the high-pressure reabsorber, a 4-ft. diameter by 40-ft. vessel operating at 350-lb. pressure and a temperature of 90°F. Vapors from the top of the high-pressure reabsorber are discharged to a 3-ft. diameter by 18-ft. high scrubber, operating under a working pressure of 375 lb. and a temperature of 100°F. From here the gas vapors pass to the two 600-hp. recompressors where they are compressed to 1500-lb. pressure before entering the suction line of the main compressors.

Vapors from the low-pressure flash tank pass into a 4-ft. 6-in. by 45-ft. low-pressure reabsorber. Gases from the reabsorber enter the fuel system after first being cleaned in the 4-ft. by 18-ft. low-pressure gas scrubber.

Condensate from the low-pressure flash tank is discharged to a 12-ft. diameter by 40-ft. horizontal depropanizer feed tank where it is joined by the product from the still-rectifier. This product is the result of the absorption oil from the high-pressure absorbers passing to the high-pressure reabsorbers from which the total rich oils of the absorbers and reabsorbers are trapped to the low-pressure reabsorber, being then discharged through heat exchangers to a 5-ft. diameter by 9-ft. vapor-oil separator, to the rich oil heater, to the still-rectifier. The latter is 72 in. diameter by 55 ft. 6 in. high. The product from the still-rectifier is discharged to the depropanizer feed tank. This product is here combined with the condensate from the low-pressure flash tank and is pumped by a 3550-r.p.m. centrifugal pump driven by a 75-hp. motor to the depropanizer preheater (1 ft. 8 in. diameter by 16 ft. long), then through the depropanizer heat exchanger (1 ft. 8 in. diameter by 16 ft. long) where it is heated to a temperature of 300°F. and is then fed to the depropanizer about two-thirds up the column. The depropanizing column is 5 ft. 6 in. in diameter by 76 ft. 6 in. high and operates at a pressure of 350 lb. Overhead vapors are passed through condensers into a 5-ft. by 8-ft. accumulator. A part of this propane is used to reflux the depropanizer and the excess enters the injection system to be returned to the producing sands.

The propane-free product from the depropanizer leaves through a 10-in. line at the bottom of the column and passes to a 4-ft. 6-in. by 2-ft. 9-in. by 16-ft. reboiler, thence to a 1-ft. 8-in. by 16-ft. heat exchanger, to an 8-in. by 16-ft. debutanizer preheater. After passing through this preheater the flow is to the debutanizer. Gases are taken overhead from this column through condensers to a 5-ft. by 8-ft. accumulator. Reflux to the debutanizing column is pumped by a centrifugal pump. Excess butane may either be sent to storage from here or the butane may be pumped through an auxiliary heater as feed for the de-*iso*butanizer. If the former course is adopted the stabilized product taken from the bottom of the debutanizer reboiler flows through a 4-in. line to an 8-in. by 16-ft. cooler, to storage. This product is propane- and butane-free condensate of approximately 12-lb. Reid vapor pressure. If the latter course is adopted the product comes out of the preheater and is discharged directly to the de-*iso*butanizer. The stabilized product of this tower is normal butane, which is sent to storage. *Iso*butane is taken overhead through condensers to the 5-ft. by 8-ft. *iso*butane accumulator. A part of this is used to reflux the de-*iso*butanizer, the excess going through a cooler to storage.

An alternate process to that just described can be followed to manufacture commercial butane, gasoline, and kerosine. In this process the propane-free product from the depropanizer can be fed to the de-*iso*butanizer to remove total butanes, providing a butane- and propane-free product for the debutanizer column, which in this case would be termed the gasoline-kerosine fractionator. Gasoline would be taken overhead and kerosine or condensate off the bottom. In this process there is no separation of *iso*butane and normal butane.

Absorption Oil System

Lean oil is pumped to the high-pressure absorbers by three high-pressure 3¾ by 18 pumps driven by 4-cylinder, 185-hp., vertical V-type, heavy-duty gas engines. The engines are operated at 387 r.p.m. Rich oil flows from the high-pressure absorbers to the high-pressure reabsorber, to the low-pressure reabsorber, through heat exchangers, to a 5-ft. by 9-ft. vapor-oil separator, to the rich oil heater, entering at 310°F. and being discharged at a temperature of 550°F., thence to the still-rectifier. Here the lean oil stream is split. The oil to be used for absorption purposes upon leaving the still goes through three heat exchangers of 3 ft. diameter by 16 ft., and 3-ft. by 16-ft. final coolers where it is picked-up by a centrifugal pump and discharged to the low-pressure reabsorber, to the suction of the high-pressure reabsorber pump, and to the high-pressure absorber pumps. The other stream leaves the still-rectifier and goes to a 10-ft. by 40-ft. surge tank. It is picked-up from this tank by a centrifugal pump and discharged to the lean-oil circulating heater, leaving the heater at a temperature of about 480°F., to be re-

COTTON VALLEY PROJECT

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Many tons of Airco Electrodes were used in the construction of this — one of America's largest and most modern natural gasoline cracking plants. In addition, ten Wilson Arc Welders were on the job speeding completion of this important defense project . . . And little wonder the management selected Airco— for the combination of Airco Electrodes and Wilson Welders has earned wide fame for their outstanding ability to produce strong, sound, leakproof welds. Once pipe has been properly joined with the Airco Electrode developed for that specific application, it's joined for keeps.

Just as Airco products have helped speed construction at Cotton Valley, they can also speed fabrication wherever metal must be joined or cut, hardened or softened, descaled or cleaned prior to painting or repainting. Problems on any application of the oxyacetylene flame or electric arc will be gladly considered.

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Anything and Everything for **GAS WELDING or CUTTING and ARC WELDING**

A group of heat exchangers, preheaters, and reboilers on processing equipment

turned to the various preheaters and reboilers where it serves as the heating medium. After passing through the various preheaters and reboilers the oil is pumped to the lean-oil circulating tank.

Both the rich oil heater and the lean-oil heater are of the direct-fired type. The former has 16 burners and the latter 32.

Compressor Units

Compressors consist of twelve 600-hp., angle-type units, ten of which are equipped with forged-steel cylinders for cycling, and two with double-acting cast-steel cylinders for recompressor service. Power cylinders on all units are 14 in. by 14 in.; compressor cylinders are 3½ in. by 14 in., and recompressor cylinders, 5½ in. by 14 in. Briefly, the principal features of the engines are: (1) multiple-cylinder, medium-speed, designed for high-pressure service; and, (2) full force-feed lubrication with oil under pressure to all bearings and oil-cooled pistons internally cooling the engine in which heat is rejected through heat exchangers to water. This type of cooling, together with the size of the bearings, reduces bearing trouble to a minimum.

An important feature of the Cotton Valley installation is that all engines are equipped with four double-acting compressor cylinders, which gives them a wide range of flexibility. This factor makes it possible for each cylinder to have its capacity reduced by removing or lifting a suction valve on each end of the cylinder, which gives the wide range of flexibility necessary to meet any condition that might arise. This flexibility is highly desirable in cycling operations because for maximum output the engines should be operated at maximum efficiency. Clearance is ineffective as an unloader under most conditions of cycling because the ratios of compression are so low that extremely large volumes of clearance are necessary; so large, in fact, that normally they are impracticable to use. The only method of obtaining good control, therefore, is to have a large number of cylinders. By having these the piston displacement can be readily controlled either by lifting suction valves or varying the speed of the engine, making an infinite number of control steps possible.

Fuel Injection

The fuel injection mechanism is a small poppet valve operated by a push rod. Pressure to the injection valve is controlled by a governor, and, as a consequence, the engine is not sensitive to variation in B.t.u. content of the gas and operates efficiently over a wide range of fuel conditions.

Scavenging

Power cylinders are scavenged with air under a pressure of 3 to 3½ lb., the air being pumped by a separate compressor that is directly connected to the engine shaft. Approximately 26 percent excess air is provided for all power cylinders, making it possible for the engines to carry temporary overloads.

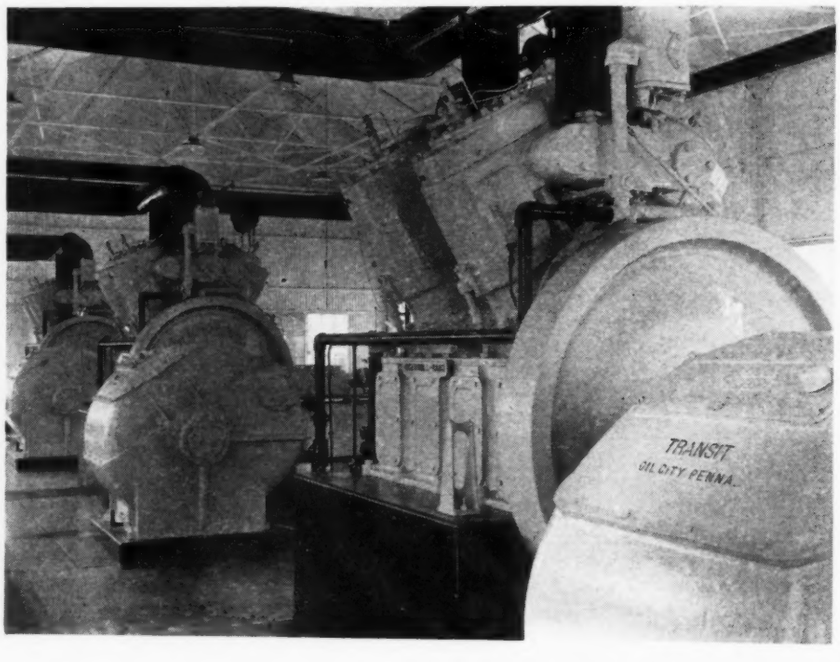
Pistons Oil Cooled

The pistons are oil cooled. Oil is forced upward through the connecting rod and piston to a space beneath the crown of the piston. As it moves through this space at high velocity, it removes a considerable amount of the heat from the piston. The oil is then returned to the crankcase where it is picked-up by a gear-type pump and forced through a bauxite-type filter and oil cooler.

Full Force-Feed Lubrication

As mentioned, the compressor units are equipped with full force-feed lubrication. Oil is fed under pressure to a header in the crankcase, first, however, being cooled and filtered to remove all foreign matter of more than one-thousandths of an inch. From the header the oil passes to the main bearings along the crankshaft, through drilled

Three high-pressure pumps driven by 185-hp. vertical, V-type engines pump lean oil to the absorbers



Largest of 10 BRADEN Buildings in Cotton Valley Recycling Project, Cotton Valley, La. Houses 7,200 H.P. battery of compressors.

WORLD'S LARGEST RECYCLING PLANT HOUSED IN BRADEN BUILDINGS

The Cotton Valley Operators' Committee recycling plant, at Cotton Valley, Louisiana, is greater than any previous plant of its kind, incorporating an entire field in its pressure maintenance program. It is designed to pass 150,000,000 cubic feet of gas daily. A total of 7,200 H.P. is installed to compress gas for injection. (See BRADEN Building above, which houses battery of compressors.) In its volume of output, it dwarfs all other plants, for the high yield of condensate from Cotton Valley gas will facilitate an estimated daily production of 10,000 barrels of stabilized condensate and about 2,500 barrels of butanes.

BRADEN Buildings, 10 in all, were selected by the Cotton Valley Operators' Committee to house this world's largest recycling plant. BRADEN Buildings are always the choice when operators want the following features:

- Durability
- Speed of Erection
- Standardized Parts
- Low Ultimate Cost
- Portability
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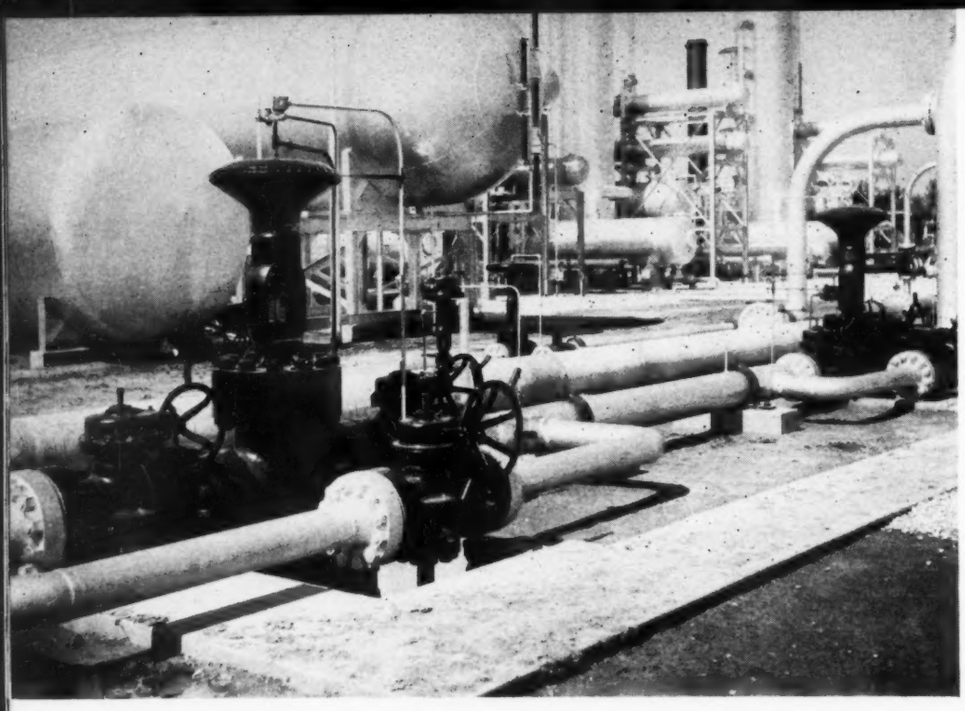
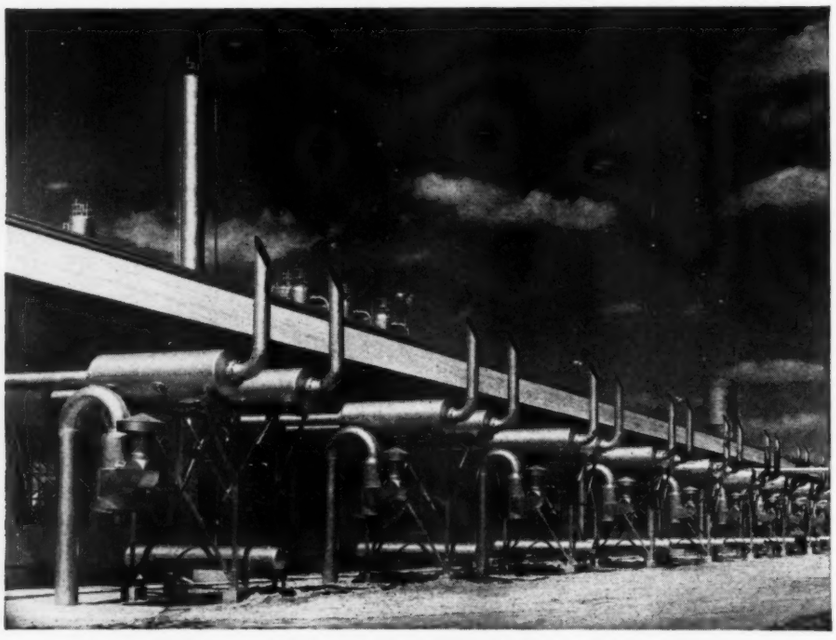
Gulf Coast Representative: R. W. (Bob) Rogers, 229 Shell Bldg., Houston, Texas.
Telephone Preston 5141

Application of the most advanced recycling methods will result in a 40% increased recoverable condensate—recovery of butanes—improved gas conservation—and added oil recovery from the field's rim, accruing greater returns at a shorter pay-out to operators and royalty owners alike.

BRADEN



Two diaphragm motor valves installed on main intake line to plant. One acts as a safety shutoff valve, the other is the primary pressure reducing valve



Free air filters and exhaust silencers outside main engine room

holes in the connecting rod to the wrist pin bearings.

Miscellaneous Features

The design of the units is such that every part requiring inspection or adjustment is readily accessible. The crankcase is provided with large handhole openings and the covers are equipped with hand grips. Bearing replacement is easy, particularly the main bearings as they are bronze-babbitt liners that can be easily rolled-out.

The crankcase is of deep, well-ribbed, heavy construction and is made of cast iron having a tensile strength of 30,000 to 35,000 lb. per sq. in. All cranks have individual main bearing supports. The crankshaft is a single piece of normalized steel forging and has a tensile strength of 90,000 to 95,000 lb. per sq. in. with a high elastic unit. Crank pins, checks, and main bearings are exceptionally heavy, and all are bronze babbitted and force-feed lubricated. The engine cylinders are made of a high-grade semisteel alloy and are completely water-jacketed. Power cylinder heads are of the same material. Cylinders and cylinder heads are heat-treated to remove casting strains. The cylinder heads are single castings, and have but one valve, the fuel injection valve. Connecting rods are of high tensile strength steel (80,000 to 90,000 lb. per sq. in.). The rods are long in relation to the stroke of the engine, which results in a very small side thrust.

Starting Air

Two 6 by 3½ by 5 compressors driven by 10-hp. motors provide 250-lb. starting air pressure. A 5 by 3 by 3½ compressor driven by a 7½-hp. gasoline engine serves as a standby.

Rim Gas

Gas production from rim oils wells, of which there are 43, is brought to the plant through three 8⅝-in. lead lines, in the manner discussed under the heading "Gathering System." At the plant the gas is passed through three 500-lb. separators, then is sold commercially or returned to the producing sands for pressure maintenance. Four consuming companies purchase this gas, taking suction directly from a 10-in. header at the plant.

The rim wells are producing from the "D" sand at 8250 ft., the Bodcaw sand at 8450 ft., and the Pardee sand at 8450 ft.

Water

Water is supplied by two wells, one serving as an auxiliary. Both wells were drilled to a depth between 500 and 600 ft., but are being pumped from a water sand at 200-ft. depth by motor-driven, submerged centrifugal pump. The capacity of this pump is 350 gal. per min., but only about half that volume is required by the plant. Water is pumped from the well into a 2000-bbl. storage tank 25 ft. high and 25 ft. in diameter from whence it overflows into the cooling tower. It is then circulated to the various coolers and condensers by two centrifugal pumps having a capacity of 4325 gal. per min. at 26-lb. pressure and 1150 r.p.m. The pumps are driven by 75-hp. motors and have a 12-in. discharge and 14-in. suction. An identical unit serves as a standby.

Two centrifugal pumps having a capacity of 5000 gal. per min. circulate water through the engine jackets. The pumps are driven by 150-hp. motors, have a 14-in. suction and 12-in. discharge, and operate at a speed of 1150 r.p.m. with a discharge head of 41 lb. One of the units serves as a spare. The engine jacket circulation system is entirely enclosed. Water is pulled from a 3000-gal. surge tank through an 18-in. line to the suction of the pump, is then discharged through a 14-in. line to four jacket-water coolers, thence to the engine jackets. From the engine jackets it is returned to the surge tank.

Cooling Tower

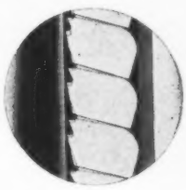
The cooling tower, of the induced draft type, is 243 ft. long, 20 ft. wide,

POSITIVE GRIP

1 WHEN SLIPS ARE DROPPED IN BOWL, the Dogs roll upward slightly . . . Notice how the patented tooth design insures positive gripping even after teeth are worn.

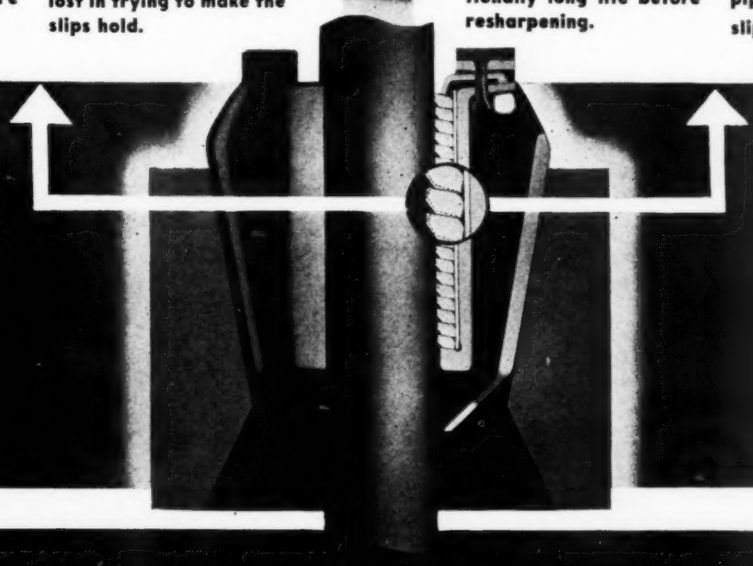
2 WHEN LOAD IS TAKEN BY SLIPS, the Dogs roll downward to grip the pipe firmly . . . This positive gripping saves much time usually lost in trying to make the slips hold.

INSTANT RELEASE



3 NOW SLIPS ARE SUPPORTING PIPE: The small, non-continuous dog teeth grip the pipe firmly with minimum damage. These teeth give exceptionally long life before resharpening.

4 NOW LOAD IS TAKEN OFF SLIPS: Notice how the dogs roll upward and away from the pipe — releasing the pipe and releasing the slips from the bowl.

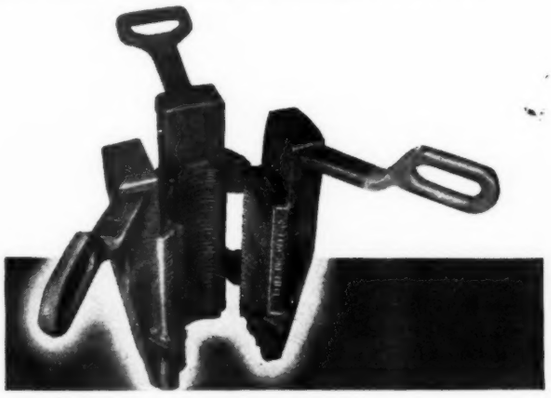


For faster, safer handling of pipe . . .

Mission *"Rolling Dog"* Slips

MISSION EXTRA-LONG ROTARY SLIPS (shown below) safely handle the longest, heaviest string of pipe. The extra large gripping area assures complete protection from bottlenecking of any string of pipe that can be run.

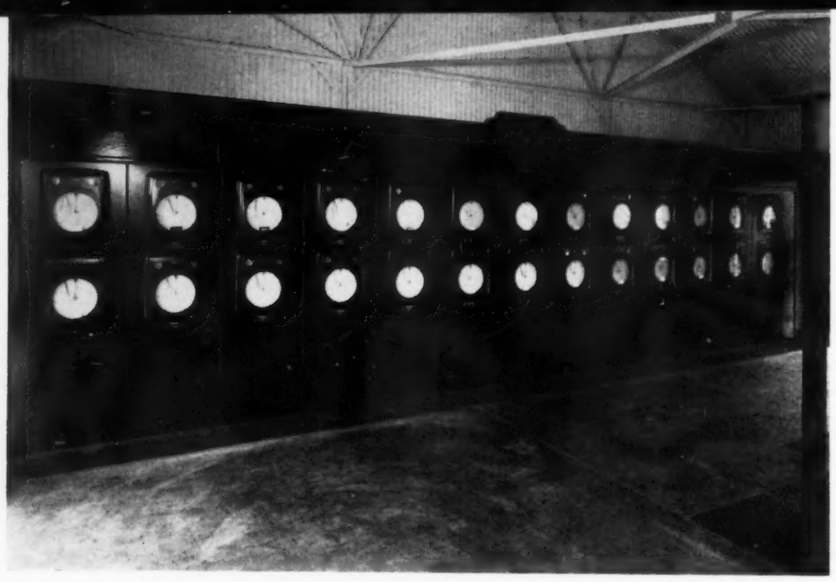
There's a size and style of Mission "Rolling Dog" Slips to suit your needs. See your Composite Catalog for full details.



The positive grip and instant release of Mission "Rolling Dog" Slips mean faster, safer handling of pipe . . . The drawings shown above illustrate how Mission "Rolling Dogs" give these advantages.

In addition to the advantages resulting from Mission "Rolling Dogs," the light weight, perfect balance, and well designed handles of Mission Slips *save time and reduce operator fatigue.* Find out, as thousands of other operators the world over have done, just how much time and trouble these slips save you. Order a set from your supply store today. Mission Manufacturing Co., Houston, Texas. Export Office, 30 Rockefeller Plaza, New York.

MISSION
ROLLING DOG SLIPS



Dual panel for recording pressures, temperatures, and volumes

and 30 ft. high. The downdraft is provided by ten 10-ft. diameter fans individually driven by 25-hp. squirrel-cage motors. These fans each have an air delivery rating of 138,000 cu. ft. per min, at 4-in. static pressure. The capacity of the tower is 4650 gal. per min.

Power Plant

Electrical power necessary for the operation of the plant is generated by four 375-kva. alternators direct connected to four 370-hp., 400-r.p.m., vertical V-type, 4-cycle, heavy-duty gas engines. The latter have a bore of 11 in. and a stroke of 13½ in. The 7½-kw. exciters are V-belt driven from each generator. The power plant switchboard is complete with automatic voltage regulators and synchronizing equipment. The plant when operated at full capacity will produce 15,000 kw-hr. per 24 hours.

Steam

Steam is provided by two 120-hp. water-tube boilers operated at 200-lb. pressure. The boiler feedwater tank has a capacity of 200 bbl. and the two 6 by 4 by 6 reciprocating duplex feedwater pumps are steam driven. As steam condensate is used for boiler feed only a small volume of makeup water is required from the storage tank.

Storage

Four 2000-bbl., 85-lb. pressure, blimp-type tanks serve as storage for *iso*butane. Normal butane is stored in six 2000-bbl., 50-lb. pressure, blimp tanks; condensate and gasoline in two 20,000-bbl., 5-lb. pressure hemispheroid tanks and two 10,000-bbl., 5-lb. hemispheriod tanks. All pressure tanks are equipped with gauging and sampling units, and pressure regulators consisting of gauging indicators and relief valves. One type of gauging unit in use consists of a rubber plug swinging gate valve on top of which is mounted a look box and tape sheave case. The rubber plug valve allows the tanks to be shut-off from the look box with the tape in the tank without damage to the tape. The tape sheave case can be swung free of the look box by means of a quick-opening coupling, thus exposing the tape to permit chalking at the approximate tank level to obtain a "cut" on the tape for gauging. A sampling and temperature bomb is used in conjunction with this gauging equipment. This permits approximately 1-qt. samples to be withdrawn from the tank, either running or spot samples.

A type of pressure and relief valve in use is a combination spring-and-weight loaded on the pressure side and deadweight-loaded on the vacuum side. Large port areas and non-metallic valve insert rings provide tight shutoff. The large ports provide high capacity for a given valve size and the spring-and-weight loading insure minimum blow-down.

Process Pumps

A complete list of the process pumps follows:

Lean oil pump—type, centrifugal; capacity, 597 gal. per min.; speed, 3530 r.p.m.; head, 322 ft.; hydrostatic test, 450 lb.; driven by 60-hp. motor.

Spare oil pump—type, centrifugal; capacity, 650 gal. per min.; speed, 3550 r.p.m.; head, 375 ft.; hydrostatic test, 600 lb.; driven by 75-hp. motor.

Rich oil pump—type, centrifugal; capacity, 650 gal. per min.; speed, 3550 r.p.m.; head, 375 ft.; hydrostatic test, 600 lb.; driven by 75-hp. motor.

Two depropanizer reflux pumps—type, centrifugal; capacity, 285 gal. per min.; speed, 3500 r.p.m.; head, 160 ft.; hydrostatic test, 650 lb.; driven by 15-hp. motors.

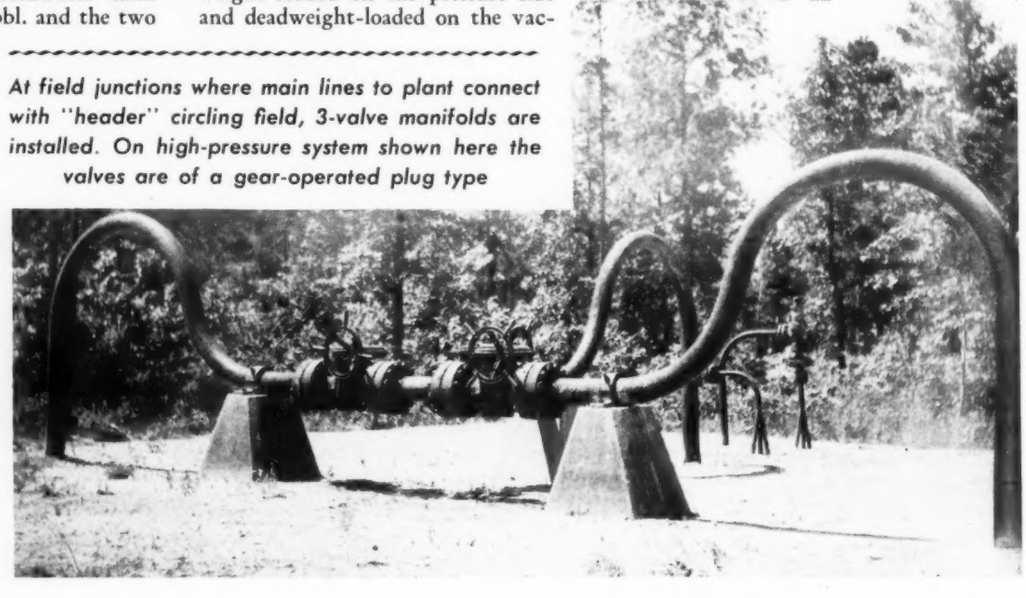
Two lean oil circulating pumps—type, centrifugal; capacity, 820 gal. per min.; speed, 3530 r.p.m.; head, 250 ft.; hydrostatic test, 450 lb.; driven by 60-hp. motors.

Two still reflux pumps—type, centrifugal; capacity, 119 gal. per min.; speed, 3490 r.p.m.; head, 170 ft.; hydrostatic test, 600 lb.; driven by 7.5-hp. motors.

Two depropanizer feed pumps—type, centrifugal; capacity, 416 gal. per min.; speed, 3550 r.p.m.; head, 1260 ft.; hydrostatic test, 800 lb.; driven by 125-hp. motors.

Debutanizer reflux pump—type, centrifugal; capacity, 330 gal. per min.; speed, 3525 r.p.m.; head, 319 ft.; hydrostatic test, 450 lb.; driven by 30-hp. motor.

Spare debutanizer reflux pump—



At field junctions where main lines to plant connect with "header" circling field, 3-valve manifolds are installed. On high-pressure system shown here the valves are of a gear-operated plug type

TABLE I

Operating temperatures and pressures

	Temperature, °F.
Raw water to cooling tower	100
Raw water from cooling tower	78
Raw water out engine jacket coolers	98
Engine jacket water to coolers	96
Engine jacket water out coolers	94
Water out of oil coolers	96
Oil out of still	400
Oil out of exchangers	140
Oil out of cooler	85
Oil out of high-pressure absorbers	83
Oil out of high-pressure reabsorber	84
Oil out of low-pressure reabsorber	82
Gas into high-pressure absorbers	80-90
Gas out of high-pressure absorbers	95
High-pressure compressor discharge	195
Recompressor discharge	198
Circulating lean oil to heater	420
Circulating lean oil from heater	480
Rich oil to heater	310
Rich oil from heater	550
Int. circulating lean oil	380
Circulating lean oil out still reboiler	500
Circulating lean oil	365
Still top	270
Still bottom	450
Still reflux	83
Water out of still condenser	118
Feed to depropanizer exchangers	80
Feed out of depropanizer exchangers	300
Feed out of depropanizer preheater	
Depropanizer top	127
Depropanizer reboiler	375
Depropanizer bottoms out of exchanger	180
Depropanizer reflux	90
Water out of depropanizer exchanger	86
Feed to deisobutanizer preheater	195
Feed out of deisobutanizer preheater	270
Deisobutanizer top	125
Deisobutanizer reboiler	180
Deisobutanizer reflux	92
Water out of deisobutanizer condenser	120
Isobutane to storage	90
N-Butane to storage	90
Feed to gaso.-kero. preheater	230
Feed out of gaso.-kero. preheater	280
Gaso.-kero. top temperature	125
Gaso.-kero. bottom temperature	370
Gaso.-kero. reflux temperature	90
Water out of gaso.-kero. condenser	120
Distillate to storage	90
	Pressure, lb. per sq. in.
Inlet scrubber	1500
Gas in absorber No. 1	1500
Gas in absorber No. 2	1500
Gas in absorber No. 3	1500
Outlet scrubber	1500
Suction header	1500
High pressure discharge	2850
Recompressor suction	320
Recompressor discharge	1500
High-pressure reabsorber	350-360
Low-pressure flash tank	100
Low-pressure reabsorber	82
Rich oil flash tank	100
Still	
Depropanizer feed	86
Propane pump discharge	1600-2000
High-pressure reabsorber and lean oil pump discharge	
Lean oil pump discharge	135
Rich oil pump suction	
Rich oil pump discharge	218
Circulating lean oil pump	175
Field gas	1850-2000

type, centrifugal; capacity, 238 gal. per min.; speed 3540 r.p.m.; head, 378 ft.; hydrostatic test, 450 lb.; driven by 40-hp. motor.

Gasoline reflux pump — type, centrifugal; capacity, 238 gal. per min.; speed, 3540 r.p.m.; head, 378 ft.; hydrostatic test, 450 lb.; driven by 40-hp. motor.

Two high-presure lean oil pumps—12 by 7½ by 12, simplex, steam driven.

Excess propane pump—28 by 5½ by 18, simplex, steam driven.

Buildings

Except for the office building, which is of frame construction, buildings throughout the plant are of steel framework covered with corrugated steel. Dimensions of the various buildings are: compressor building, 328 ft. 1 in. long by 35 ft. wide; lean oil pump house, 71 ft. 1 in. by 37 ft. 5½ in.; power plant building, 90 ft. by 36 ft. 1 in.; process pump house, 90 ft. 1 in. by 26 ft.; water pump house, 50 ft. 1 in. by 20 ft.; boiler feed pump house, 10 ft. by 10 ft., and three fire houses, which are 8 ft. by 8 ft.

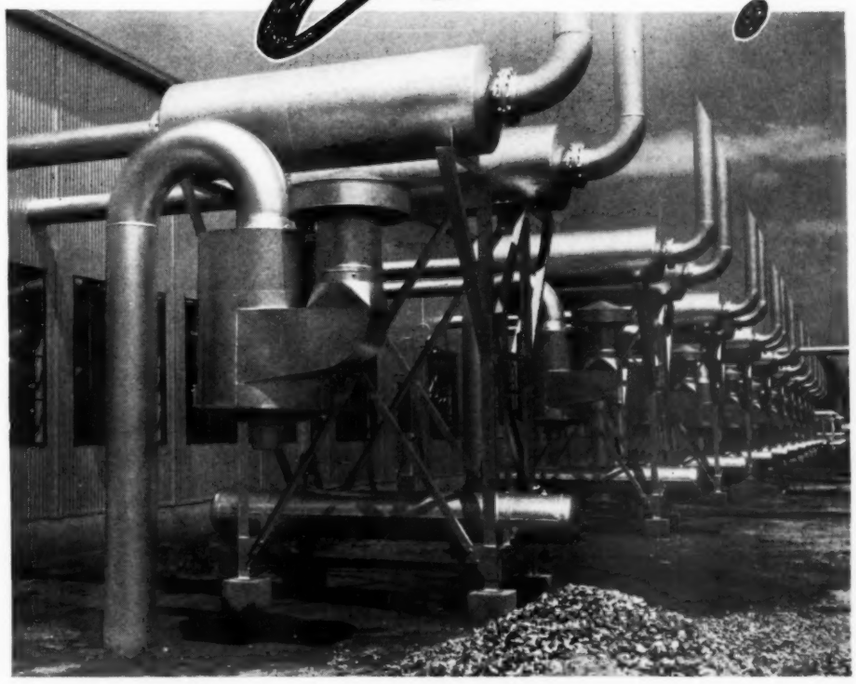
Fire-Fighting Equipment

Portable (wheeled) fire-fighting equipment of both the carbon dioxide and chemical foam types is installed in the plant. In addition to this, smaller carbon dioxide extinguishers are placed at strategic points throughout the plant. Water for fire-fighting purposes is available through 35 hydrants and increased pressure during a fire emergency is obtained by means of a V-8 engine driving a centrifugal pump. For certain types of fires, generators may be inserted in the fire hose lines for the purpose of injecting foam-producing chemicals.

Producing and Injection Wells

There are 81 condensate-producing wells. Of these, 77 are producing from

AGAIN A MAJOR GAS PRODUCER SELECTS Vortox!



Cotton Valley Operators Committee, Cotton Valley, Louisiana

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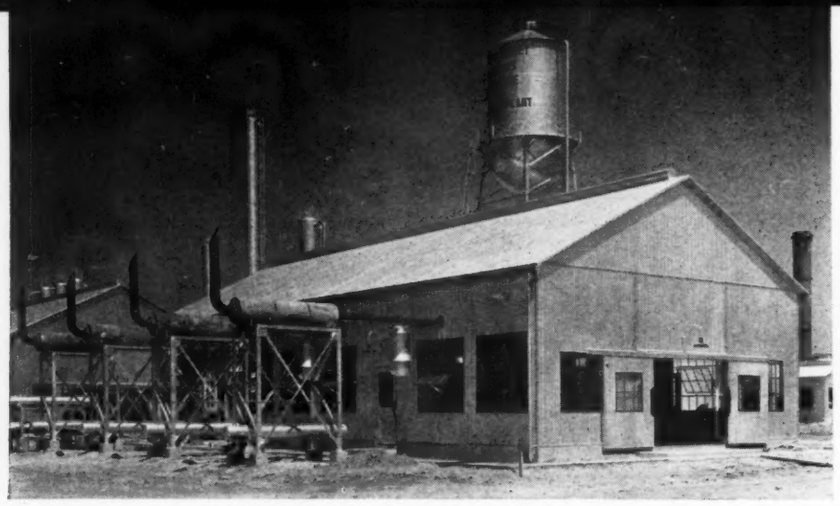


Air filters and silencers on gas engines driving generators

the Bodcaw sand at depths of 8000 ft. or greater, and 4 from the "D" sand at 7900 ft. Vertical meter runs are installed at each well; gas is metered at the plant intake behind the inlet scrubber.

Injection is into 7 key wells, 5 in the Bodcaw sand and 2 in the "D" sand. The main injection line is 6⅝ in. and laterals from it to the 6-in. meter runs are 4½-in. At the well the injection line forms a Y, one line discharging gas into the tubing, the other into the casing. Both the annulus and tubing are open to injection. Injection is at a pressure of 2900 lb. to the "D" sand and 2800-2850 lb. to the Bodcaw sand. A meter run is installed at each key well.

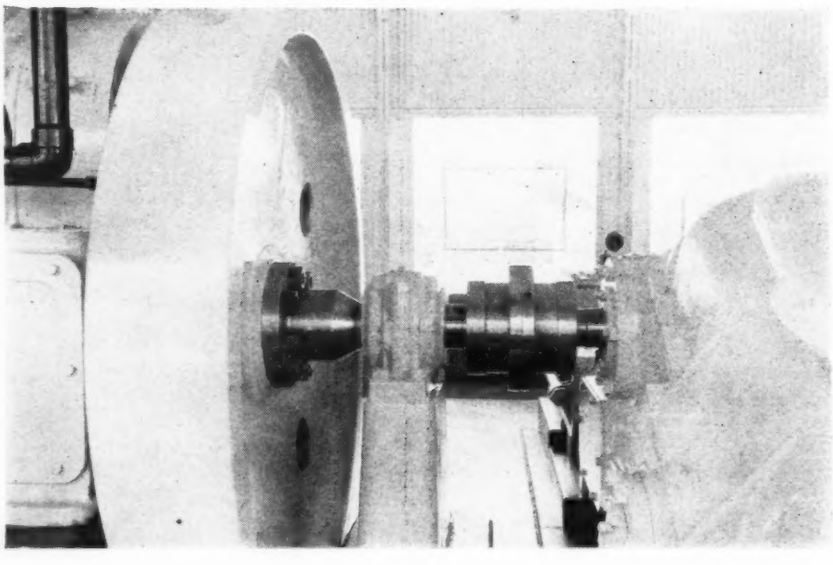
Contractor

The contractor in charge of construction of the Cotton Valley plant was the Hudson Engineering Company of Houston, Texas.

Equipment Used

Air Maze Corporation—Air filters.
Air Reduction Sales Company—Welding electrodes.
Aleo Products Division of American Locomotive Company — Coolers, heat exchangers, reboilers, condensers, and preheaters.
Alcorn Combustion Company—Rich- and lean-oil heaters.
American Air Filter Company, Inc.—Air filters.
American Hammered Piston Ring Division of Koppers Company—Piston rings and packing.
American-La France–Foamite Corporation—Fire-fighting equipment.
Armstrong Machine Works—Steam traps.
Babcock and Wilcox Company—Fire brick in oil heaters.
Barrett Company—Pipe-line coating.
Bartlett-Hayward Division of Koppers Company—Fast's flexible couplings.
Beaird Corporation, J. B.—Blimp type product storage tanks.
Black, Sivalls and Bryson, Inc.—Safety head flanges on compressor manifold.
Braden Steel Company—Steel buildings.
Brance-Krachy Company, Inc.—Electrical equipment.
Burgess Battery Company—Silencers on compressors.
Chicago Bridge and Iron Company—Hemispheroid product storage tanks.
Clark Bros. Co.—Gas compressors and recompressors.
Consolidated Ashcroft Hancock Division of Manning, Maxwell and Moore—Gauges.
C. Lee Cook Company—Piston rings and packing.
Coppus Engineering Corporation—Steam turbines.
Crane Company—Valves and ells.
Crane Packing Company—Packing.
Crouse-Hinds Company—Condulet and electric fittings.
Cutler-Hammer Company—Voltage regulators.
Daniel Orifice Fitting Company—Piston type check valves; orifice fittings.
DeBothezat Ventilating Equipment Division American Machine and Metals, Inc.—Cooling tower fans.
Dugas Engineering Corporation—Fire-fighting equipment.
Electric Machinery Manufacturing Company—Generators; voltage regulators.
Faber Engineering Company—Boiler burners.
Fisher Governor Company—Diaphragm motor valves, liquid level controllers.
Foxboro Company — Control instruments, instrument charts.
Gates Rubber Company—Flexible cooling circuit lines on gas engines.
General Electric Company — Motors; switchboard equipment.
Gray Tool Company—Valves on wells.
Green Fuel Economizer Company, Inc.—Fuel economizer on boilers.
Hills-McCanna Company — Force-feed lubricators.
Hudson Engineering Company — Construction contractor; cooling tower.
Inferno Company—Relief valves.
Ingersoll-Rand Company—Gas engines, pumps, and starting air compressors.
Kerotest Manufacturing Company—Valves on wells.
Latex Construction Company—Gathering line contractor.
Louis Allis Company—Motors; generator exciters.
Merco Nordstrom Valve Company—Plug valves.
McCord Lubricator Company — Force-feed lubricators on compressors and recompressors.
Mission Manufacturing Company—Gear operated valves on field gathering line junctions; valves on wells.
National Transit Company—High-pressure lean oil pumps; boiler feed pumps; water pumps.
National Tube Company—Piping; headers.
Peerless Manufacturing Company—Separators.
Peerless Pump Division, Food Machinery Corporation—Water well pumps.
Penberthy Injector Company—Sight gauges on vessels.
Pittsburgh Equitable Meter Company—High-pressure balanced valve regulators.
Plibrico Jointless Firebrick Company—Boiler setting service.
Geo. D. Roper Corporation — Lubricating oil pumps.
Scintilla Magneto Division, Bendix Aviation Corporation—Magnetos.
Shand and Jurs Company—Pressure regulators on hemispheroid storage tanks.
Square D Company—Circuit breakers and switches.
Standard Asbestos Manufacturing and Insulating Company—Insulation.
Taylor Forge and Pipe Works—Welding ells.
Texas Pipe Bending Company—Pre-fabricated piping.
Union Iron Works—Water-tube boilers.
Vapor Recovery Systems Company—Gauging and sampling equipment; pressure and vacuum relief valves.
Vortox Manufacturing Company—Air filters.
Walworth Company—Valves and tees.
Westinghouse Electric and Manufacturing Company—Auto starters; safety switches.
Wisconsin Motor Corporation—Gas engine.
W-K-M Company—Valves on wells.
Wyatt Boiler and Metal Works — Fabricated equipment, such as absorbers, scrubbers, still-rectifier, fractionating tower, depropanizer tower, pressure vessels, tanks, etc.

Flexible couplings are used between the high-pressure lean oil pumps and the 185-hp. gas engines driving them



Refinery Practice for the Operating Man

Vocational Class Proceedings in Refinery Engineering

Time and Temperature

Synopsis of Preceding Meetings

The first discussion involved a review of the various hydrocarbons and their thermodynamic qualities as related to the cracking of petroleum and its products. The main hydrocarbons in petroleum and its cracking products are paraffins, olefins, naphthenes, and aromatics. Of these olefins are virtually non-existent in most crude oils.

Points covered in the discussion included the following: (1) chemical stability of compounds; (2) relative crackability of hydrocarbons; (3) energies released or absorbed in cracking; (4) the decomposition reactions, and (5) effect of pressure on reactions.

In discussing the development of cracking, it was pointed out that the ability of petroleum to crack was discovered by the accidental overheating of a topping shell still, resulting in an unexpected straw-colored distillate, which was in reality cracked distillate.

Of the earlier cracking processes that followed the first patents on cracking granted to Young and Benton in 1865, the following were discussed: (1) the Benton unit; (2) the Burton-Clark unit; (3) the Coast still; (4) the Fleming still; (5) the Dubbs process; (6) the Isom process; (7) the Cross unit; (8) the Jenkins unit; (9) the Holmes-Manley unit; (10) the Winkler-Koch still, and (11) the Gyro vapor-phase unit.

The importance of clean recycle was first recognized when operators of earlier units discovered that clean stocks permitted longer runs with correspondingly small percentages of gas and coke formed.

In discussing the methods whereby maximum gasoline yield might be obtained by cracking, it was brought out that experience shows that a high reflux ratio results in a smaller yield of gas because of lighter cracking. It was decided to run to coke with as little gas formaton as possible. If the residue is fuel oil there is bound to be some gasoline in this liquid product.

Additional gasoline will be obtained if a multiple coil heater is used so that more rigid control from the fractionator will permit separate cracking from the various cuts at optimum conditions. Quenching will be essential to correct control of the time and temperature element.

The excessive heat brought to the fractionator from the reaction chamber can be disposed of in a number of ways: (1) the charge may be used as a quench; (2) heat can be exchanged with the charge to any adjacent unit, and (3) the remaining heat must be removed by reflux in the usual way.

The charging stock is less refractory than recycle stock. A cut cracked above its optimum temperature will produce excessive amounts of gas and coke. For maximum gasoline, therefore, it is necessary to separate both the charge and the recycle stock into small cuts. This would necessitate the separate treatment of charge and recycle. These cuts would then be treated at the temperature at which minimum gas is formed and quenched immediately to keep down the formation of polymers and condensation products that reverse the process of cracking and go to form coke. All this procedure would mean many cuts and high recycle ratio. Of course, for practical purposes the above method would have to be modified in order that investment in equipment would be within reason.

If advantage is taken of all present-day developments in cracking it was decided that 75 percent gasoline yield was about the ultimate to be expected.

The time of reaction in cracking doubles when the temperature increases approximately 20 degrees, making it difficult to control the reaction above a certain temperature; in addition, large amounts of gas and coke are obtained.

Refuting the belief that there is a large percentage of free carbon in petroleum coke, reference to several authorities indicate that, on the contrary, coke consists principally of polymerized and condensed hydrocarbons poor in hydrogen and aromatic in nature. Coke is essentially a control product in the operation of a cracking still inasmuch as it is economically necessary that its quality be high if it is to be salable.

Class Meeting No. 6 (Continued)

Leader: Then let's take an example in which we use an autoclave as the vessel in which the oil is to be cracked. If we heat this autoclave to the cracking temperature and immediately remove the gas and gasoline from the vessel, the relative volumes should determine the percent crack per pass in the furnace, shouldn't it? All right, then, under what condition would the minimum gasoline yield be formed?

Pupil: The minimum gasoline yield would be formed at the lowest practical temperature.

2nd Pupil: Did you say minimum gasoline?

Leader: Yes, what I said was minimum crack—what I meant to say was minimum cracking?

Pupil: Rate?

Leader: No, just minimum cracking.

Pupil: The lowest practical temperature in a given period of time gives minimum cracking.

Leader: Let us, for example, say that we heat to 700°F. (371°C.). No, let's make it 800°F. (427°C.) to put it in the cracking range. We would immediately get gasoline formed, would we not? All right, then we would remove that small amount of gasoline, say 1 percent, and we would again heat the oil to 800°F. It would probably take a little more time than in the first heating, but another volume, say another 1 percent, of gasoline would be formed. Now, if we continued that an infinite number of times would we get the maximum gasoline yield?

Pupil: If the charging stock could be divided so that the paraffins, aromatics, and other compounds could be segregated according to compounds and not according to distillation range, you might be able to crack at higher temperatures without sacrificing gasoline yield.

Leader: I believe that is true with the possible modification that there will be certain classes of paraffins that will be cracking in the same range as certain classes of naphthenes. If you were able to take all hydrocarbons having the same carbon number, segregate them according to paraffinic, naphthenic, and aromatics, then that would be the ideal situation.

Pupil: Then you could run at an elevated temperature for each group and not sacrifice gasoline yield.

2nd Pupil: By selecting the lowest temperature at which a pure hydrocarbon component would crack, couldn't you prevent secondary reactions?

Leader: I believe that is correct. I think that is an important point. Does everyone get the significance of that remark?

Pupil: Yes, I think that is what is really implied in that first statement.

Leader: In other words, you are selecting the temperature at which the easiest material to crack can *be* cracked.

Pupil: What do you mean by easiest —the lowest?

Leader: The one that cracks at lowest temperature. How could we expand this to clarify the statement?

Pupil: Base the temperature selection on the types of hydrocarbons that are predominant? Would that amplify it in your opinion?

Leader: Let's list the requirements.

1. Lowest temperature for selective stock.
2. Division of stock into selected fractions.

Is there any other point?

Pupil: Removal of product from the reaction zone. I am thinking of a Dubbs coking chamber.

Leader: Well, that would come under the heading of "low crack per pass." Doesn't that cover that condition?

Pupil: I don't think it is exactly the same thing.

Leader: I think we can put down here "low crack per pass" without getting into trouble.

How about pressure?

Pupil: Relatively low pressure—200 to 300 lb. per sq. in.

2nd Pupil: Concerning pressure, Sachanen shows[1] that at a temperature of 900°F. (482°C.) and a pressure of 750 lb. per sq. in., the gasoline yield was 61.5 percent, whereas at 200 lb. and the same temperature, the yield was 66.8 percent.

Pupil: I believe the consensus of a number of investigators is that pressure has very little effect on primary reaction of cracking, but it does have a marked effect in the secondary reactions. For example, in the case of unsaturates, when the pressure is increased the reaction will proceed through polymerization, etc., i.e., the high pressure will tend to increase the naphthenes present. On the other hand, if the temperature is too low, depolymerization and decomposition may occur in some cases. That obviously would be undesirable, so that is why I said medium pressures. References to this will be found on pages 38, 119, and 124 of Sachanen. I don't believe there is so much contradiction as I first thought there was.

Leader: The only contradiction is that the pressure has to be considered in connection with the factors of time and temperature.

Pupil: The aromatics are very readily condensed on down to coke, so high pressures, if you are going very high in temperature, can be detrimental if not properly controlled.

2nd Pupil: On page 117, Sachanen says "the primary cracking reactions of decomposition, leading to the formation of low molecular weight hydrocarbons, are independent of the pressure, as might be expected for monomolecular reactions." In view of this, apparently, the pressure couldn't be *too* low.

Leader: I believe that it would be safe to say that if temperatures are reasonably low and the crack per pass is reasonably low, that the pressure can vary over a wide range without detrimental effect. Isn't that correct?

Pupil: I believe it is.

Leader: As our fourth point, we will put pressure between 200 and 700 lb. per sq. in.

Pupil: From a practical viewpoint, the high pressure will give higher heat transfers, less local overheating and less coke formation, so there is an argument for high pressure.

2nd Pupil: I should like to ask what is the lowest temperature that would make the proper type of coke that would be marketable as well as be removable?

Leader: That should be Condition No. 5—modify all operations so it will produce a satisfactory coke quality as necessary. Do you think you can get satisfactory coke with maximum gasoline yield?

Pupil: No coke would be satisfactory, would it?

2nd Pupil: Can you get satisfactory gasoline from maximum yield?

Leader: I should like to bring up the question of whether or not you would get any coke with maximum gasoline yield. Let us outline what will happen when we get maximum gasoline yield. Can we put down "Low gas yield?"

Pupil: Yes.

Leader: 1. Low Gas Yield.

Pupil: Undesirable coke formation.

2nd Pupil: Low octane.

Leader: Could we say that we would get no coke formed—as a result of condensation and polymerization? Would that compromise the argument?

Pupil: I don't believe you can—I doubt the ability to avoid forming coke.

Leader: I said no coke formed as a result of condensation and polymerization.

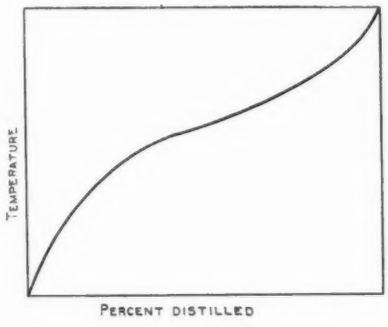
Pupil: I don't think you can avoid coke being formed through any manner.

Leader: Why don't we say, for the second part: (2) Minimum coke due to condensation and polymerization.

Someone said "low octane number." That will be the third point. Are there any others?

Pupil: Yes, you do not have good volatility.

Leader: (4) Low gasoline volatility. Are there any other conditions? Suppose we have a stock that has a boiling range like this:



What will be the boiling point of the combined cracked products? What kind of curve will they have?

Pupil: Do you mean the combined cracked products—operating on gasoline yield?

Leader: We are still talking about maximum gasoline yield. If we operate for maximum gasoline yield, what will be the character of the combined cracked products?

Pupil: No intermediate products.

Leader: That will be the fifth point. Are there any other conditions?

Pupil: You could have one other thing that might be important economically—a high lead susceptibility to go with that low octane number.

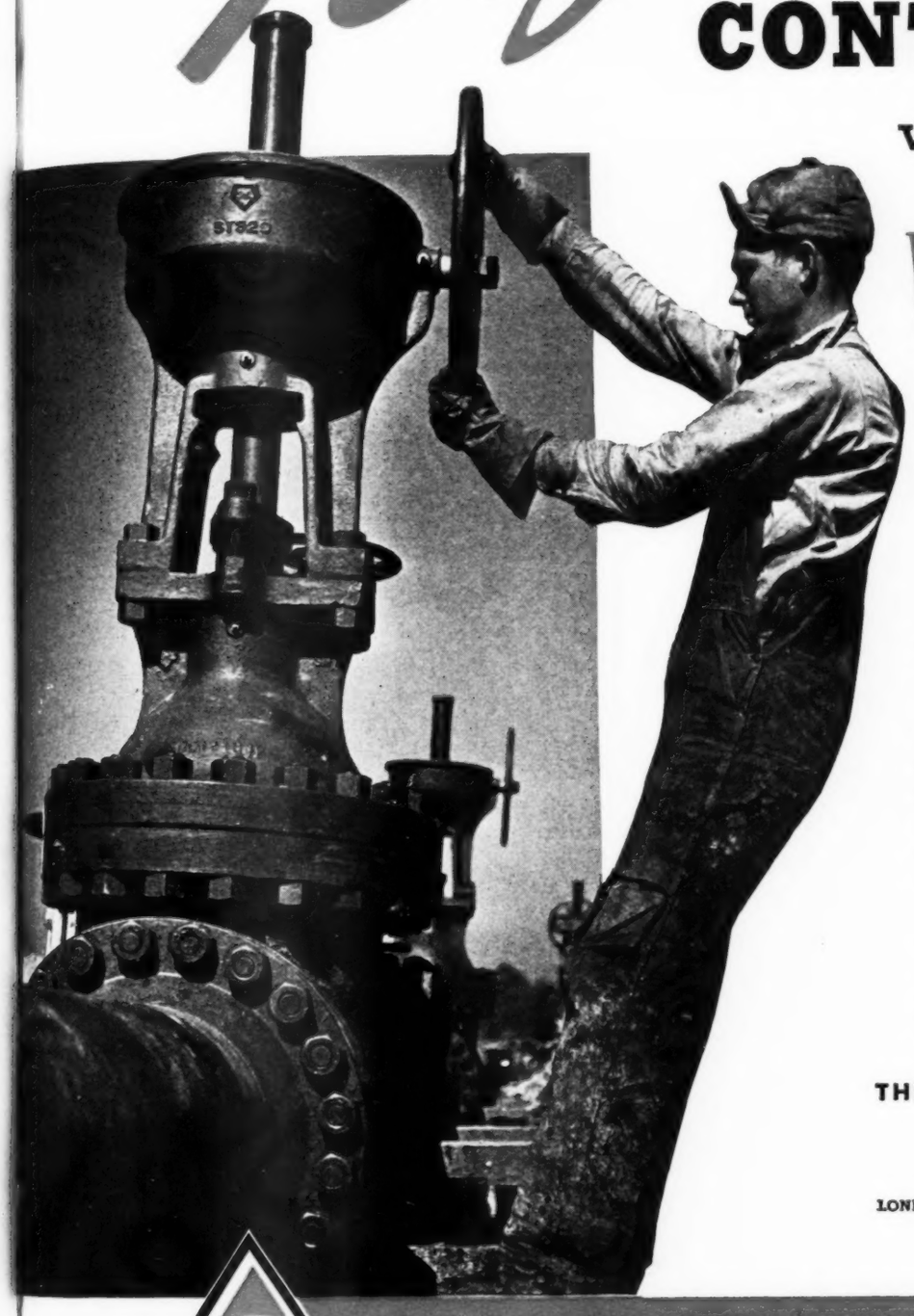
2nd Pupil: Why? We assume because it is low octane number that it is susceptible to lead.

1st Pupil: No, but you will still have a good many of the paraffinic hydrocarbons remaining as paraffins to be cracked again.

EDITOR'S NOTE: Class meeting No. 6 will be continued in an early issue of *The Petroleum Engineer*.

[1]Table 40, p. 116 of *Conversion of Petroleum* by Sachanen.

Perfect CONTROL with



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Freak Blowout in California Well

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☆Earthquake believed responsible for opening up high-pressure gas that caused unexpected blowout

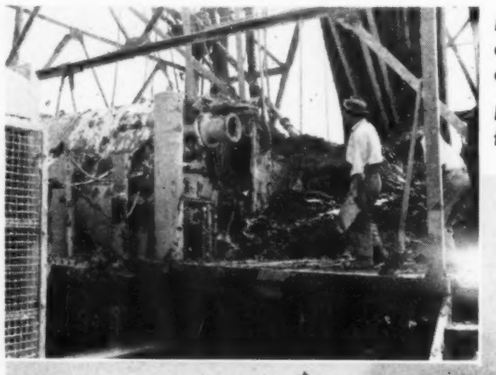
by Wallace A. Sawdon
Pacific Coast and Foreign Editor

AFTER having reached a depth of 8178 ft. in Robert S. Lytle well Anderson No. 1, located between Western and Normandie Avenues and north of Imperial Highway, just outside the city limits of Los Angeles, California, preparations were being made to run the tools back into the hole. The bit had just about been made-up on the drill collar when increased evidence of gas was observed in the hole. Hastily completing the making-up of the bit, the drill collar was inserted in the well and was in the slips when the well blew in. With no counteracting weight except that of the drill collar itself, the pressure built-up and blew the drill collar and bit from the hole. This happened at 8:30 A. M. July 1 and the well blew gas and mud until it sanded itself up and stopped flowing at 5:30 P. M. the next day, July 2.

The blow-out was caused by a gas sand picked up between depths of 1400 and 1550 ft. This sand was encountered in two wells previously drilled on the 160 acres on which the well is located and is the same formation that has blown out before in other wells in adjacent fields. Although the pressure is high the volume of gas in the sand is limited and is not in commercial quantities.

A string of 13⅜-in. surface casing had been cemented at 1021 ft. and open hole was carried from there to the total depth of 8178 ft. reached at the time of the blow-out. There have been numerous theories advanced as to what caused the gas to effect a blow-out at this particular time. One that is rather unusual but appears reasonable is that an earthquake, which occurred at midnight previous to the blowout, may have disturbed the subsurface conditions and effected entry of the gas into the hole after the drill string was pulled out. As it happened, another small blowout occurred about the same time in a well drilling in the Dominguez field a few miles to the southeast.

At time of writing the derrick and other subsurface equipment are being put into shape to enable the operator to determine whether the present well can be completed or whether it should be abandoned and another hole drilled. Excellent subsurface data were obtained during drilling so that coring and logging will not be necessary if another hole is drilled for this location.

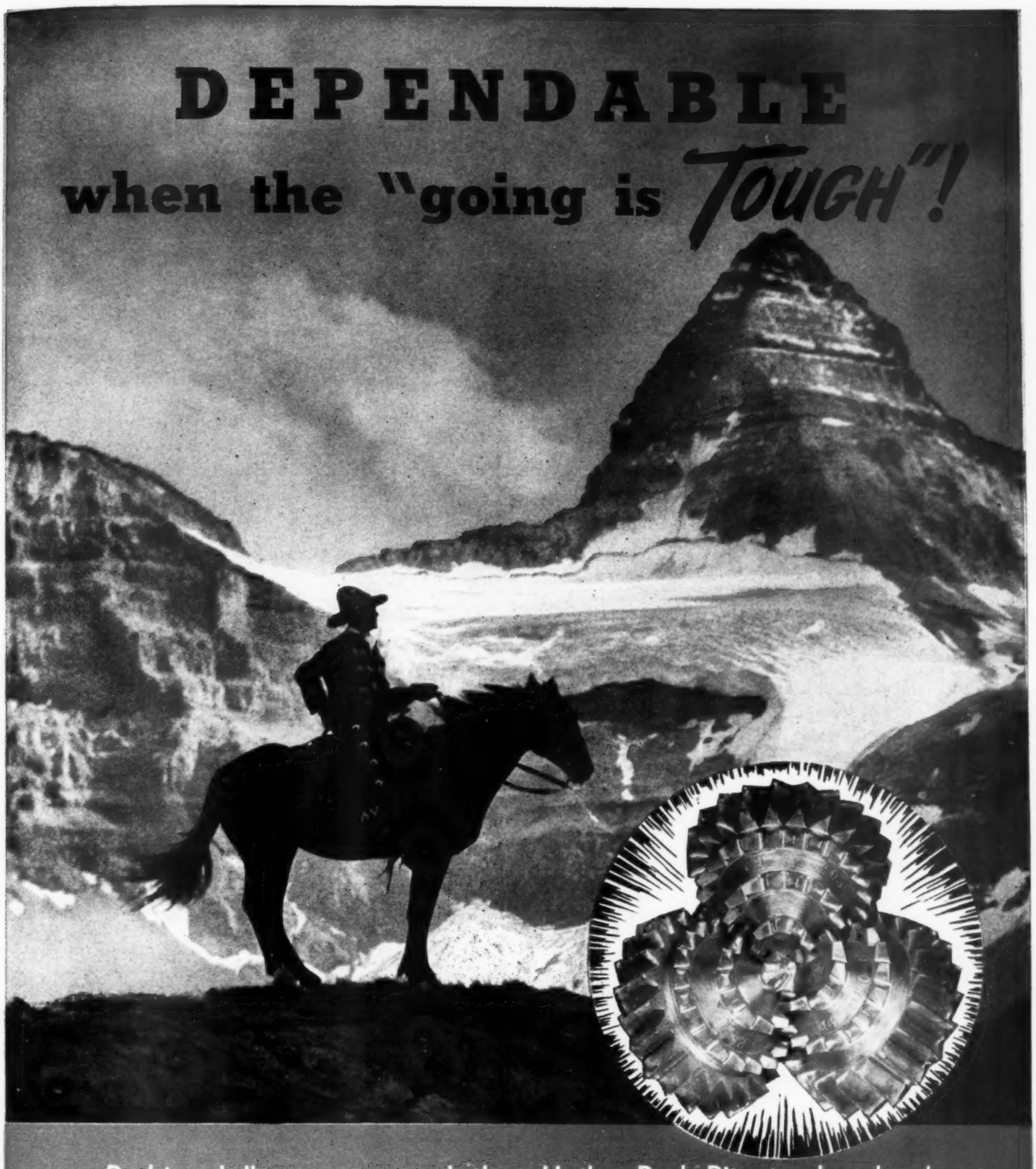


Left—Tons of mud completely covered the drawworks and derrick floor

Below—Well was uncontrolled for 33 hr. before sanding-up

DEPENDABLE

when the "going is *TOUGH*"!



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Reconditioning Oil Wells in the Greater Seminole Area of Oklahoma

PETROLEUM ENGINEER Exclusive Feature

PART 3 (Concluded)

by J. I. Laudermilk Instructor, Petroleum Engineering, University of Texas

A photograph and biographical sketch of the writer can be found on page 114 of the May issue of *The Petroleum Engineer*, in connection with Part 1 of this article.

FIG 3 shows the initial changes in production rates obtained in the past by shooting the Upper Wilcox Sand in different wells located in various pools of the Greater Seminole Area. Individual increases of as much as 500 percent have been reported; decreases of as much as 45 percent of the previous rate of production have likewise been noted. This wide dispersion emphasizes the fact that mere shooting of the Upper Wilcox Sand is not the final answer to all reconditioning problems encountered in this area, and that under unfavorable conditions a decrease in production rate may result from such work. This merely confirms the statement made earlier in this article that each well presents an individual problem and should be considered on its own merits. In the greater number of wells, however, favorable results have been obtained by this method of reconditioning. The average effect of shooting the Upper Wilcox Sand has been to cause an initial increase in production rate of 60 percent above the production rate prior to such shooting including those jobs in which decreases in rate of production were experienced.

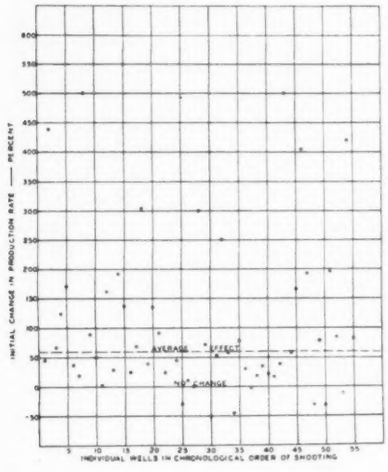

INITIAL CHANGE IN PRODUCTION RATE — PERCENT
AVERAGE EFFECT
60% CHANGE
INDIVIDUAL WELLS IN CHRONOLOGICAL ORDER OF SHOOTING

Fig. 3. Initial change in production rate resulting from shooting the Upper Wilcox Sand in the Greater Seminole Area

Fig. 4 shows the average sustained change in production rate that has resulted in the past from shooting the Upper Wilcox Sand in the Greater Seminole Area. The data available show that the average effect has been an increase of 50 percent in production rate for the six-month period subsequent to shooting as compared to the six-month period preceding the reconditioning. It will be noted that the sustained change in production rate is not so large as the initial change resulting from the shooting. This result should logically be expected as increasing the rate of production should ac-

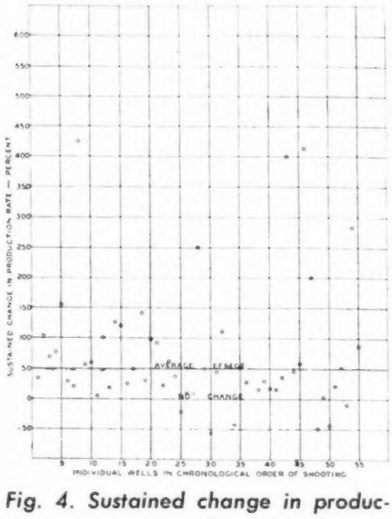
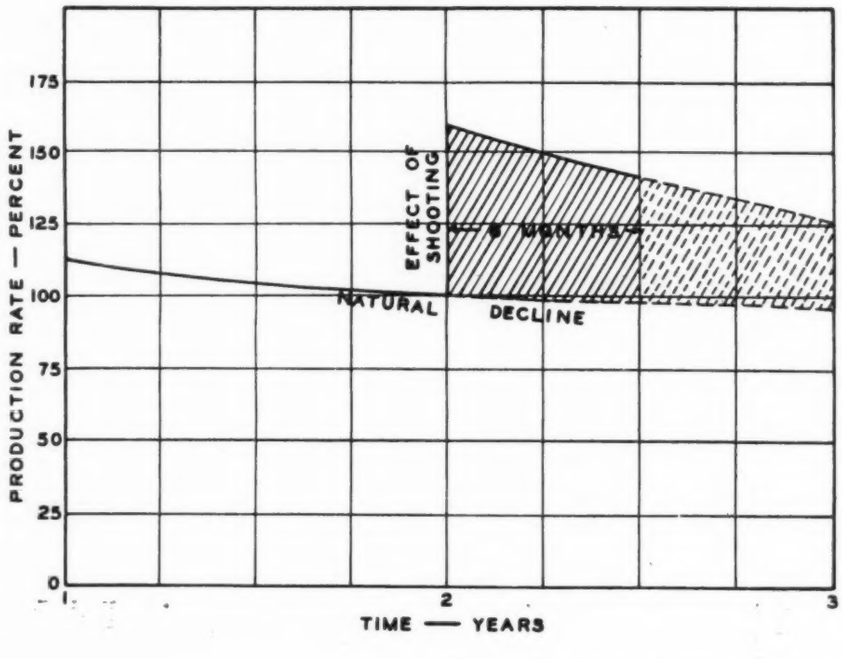

SUSTAINED CHANGE IN PRODUCTION RATE — PERCENT
AVERAGE EFFECT
60% CHANGE
INDIVIDUAL WELLS IN CHRONOLOGICAL ORDER OF SHOOTING

Fig. 4. Sustained change in production rate resulting from shooting the Upper Wilcox Sand

Fig. 5. Composite production rate curve showing the effect of shooting the Upper Wilcox Sand



Hazard WIRE LINES for America's Oil Industry

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Ever since Erskine Hazard started making wire rope back in 1846, we have devoted our engineering research, field training and experience, and manufacturing facilities to the end that Hazard Wire Ropes shall serve the users at the lowest possible cost. Many of the important developments and improvements to wire rope have been Hazard's.

We have watched the oil industry grow—had our part in aiding its development. Ninety-five years is a long time. Ninety-five years of wire rope making is a lot of experience. Hazard engineers apply this accumulated experience to your rope problems. This engineering and manufacturing experience has proved itself of real service to the wire rope users through three generations.

★ *The Green Strand Identifies Hazard Wire Ropes Made of Improved Plow Steel*

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centuate the rate of decline of the well.

Fig. 5 presents graphically the magnitude of the change in the composite production rate curve resulting in the past from shooting the Upper Wilcox Sand in the Greater Seminole Area. This composite curve shows the initial change and sustained change in production rate and the accentuated production decline.

An attempt was made to correlate the results obtained by shooting the Upper Wilcox Sand in the Greater Seminole Area with the various factors affecting the shooting of this producing zone in this area, but due to missing and fragmentary data the results were so conflicting in nature as not to permit any accurate evaluation of the individual factors.

On the basis of past results, however, it may be expected that an average increase of 50 percent in the rate of production can be obtained by shooting the Upper Wilcox Sand in wells that are suitable for this method of reconditioning. This increase in production rate will be sustained during a period of six months subsequent to such shooting. The use of this figure for estimating the increase in rate of production and the total additional production obtained during this period of time is reasonable in determining the economic justification of prospective reconditioning of oil wells by shooting the Upper Wilcox Sand in the Greater Seminole Area. Such an estimate will tend to be conservative in nature as it does not take into consideration the increased production rate beyond the end of the six-month period. This conservatism is a factor greatly to be desired in reconditioning work where operations are close to the economic margin.

Acknowledgment

The author wishes to express his appreciation to the individuals who have rendered assistance in the study of reconditioning work on oil wells. Special thanks are due Professor Richard Lee Huntington, director of the School of Chemical Engineering, The University of Oklahoma; Professor Harry H. Power, chairman of the Department of Petroleum Engineering, The University of Texas; G. C. MacDonald, production engineer, Gulf Oil Corporation, and Paul F. Lewis, manager, American Glycerine Division, E. I. du-Pont de Nemours and Company.

P 111.391.

Current Exploration and Leasing Activity in the Dakotas

OIL exploration that has been confined principally to the central sections of North and South Dakota during a year of intensive activity is reported to be spreading into other parts of the two states.

Recent developments include the arrival of a crew of oil company geologists and engineers from Texas to operate in Perkins County, South Dakota, and Adams County, North Dakota; the extension of leasing activities to Brule and Charles Mix counties in southern South Dakota; a survey of Codington, Spink, and Beadle counties by a field party from the State School of Mines, and the drilling of two test holes in the Black Hills in the extreme western part of South Dakota.

Leasing continues at an accelerated rate in the central part of the two states, according to reports, with total leases in North and South Dakota estimated as high as 7,500,000 acres. More than 50 major companies are said to be active at present with several crews conducting surveys and tests.

A test being drilled by the Noble Drilling Company of Tulsa, Oklahoma, for the Carter Oil Company on the Cedar Creek anticline in southeastern Montana, near the Dakota line, is reported to be nearly 6000 ft. deep. It is understood the well will be drilled to a depth of 10,000 ft. if necessary. Drilling was begun May 10, 1941.

The test wells in the Black Hills area are being drilled by independent operators from Newcastle, Wyoming. A test was begun last month near Fairburn in Custer County by Joe Cornacher and H. C. Howard and the other test is being made about 6 miles southeast of Rapid City by Lem Johnson for A. E. Hinman and T. P. Fenton of Rapid City. The Rapid City well, under present plans, will be drilled to the Minnelusa sand, expected at a depth of about 3000 ft.

This Black Hills area is only a few miles east of the Osage, Wyoming, oil field and has attracted some attention from wildcatters for more than a decade.

Heaviest leasing activity is reported to be in the central part of the Dakotas, including Stanley, Sully, Potter, Dewey, and Corson counties in South Dakota, and Horton, Burleigh, Emmons, McLean, McHenry, and Ward counties in North Dakota. Leasing is reported in more than 30 counties altogether.

In Stanley County, South Dakota, county-owned land under lease alone totals 80,000 acres. Largest holders of leases in the county are reported to be Kerlyn Oil Company and Magnolia Petroleum Company. In Haakon County, just west of Stanley, oil leases on nearly 70,000 acres were recorded during the last year.

The Standard Oil Company of New Jersey, Socony-Vacuum Oil Company, and Phillips Petroleum Company are extending their leasing activities into Brule, Aurora, and Charles Mix counties of southern South Dakota where oil leases are being taken on a block of land including all of Brule County, a part of Charles Mix, and a part of Aurora.

Their leasing representative reported that two rigs would be shipped into the area by the three concerns upon completion of the leasing program.

Two tracts of land were leased at the first auction sale of oil and gas leases by the South Dakota school and public lands department under the terms of a revised law adopted this year. One tract of 640 acres in Dewey County was bid in by the firm of Leverson and Moser, Tulsa, Oklahoma, and a second tract embracing lands owned by the department in Harding County, including a portion of the Little Missouri River bed, was bid in by M. O. Miller of Baker, Montana.

Both bids were at the minimum price of 10 cents per acre plus a bonus of $1.00. The leases run for 10 years. Applicants for leases of school department lands are required to advertise their application in the county in which the lands sought to be leased are situated for a period of 30 days prior to the sale of leases.

A measure creating an oil and gas board to regulate explorations in South Dakota was prevented from becoming effective July 1 by a petition to refer it to the South Dakota voters.

The petition was circulated by the Independent Oil Producers' Association, whose president, Dr. I. P. Tieszen of Marion, declared that the law passed by the legislature last winter "exempts the major oil companies from compliance with its rules and regulations. It provides that small independent operators who are drilling in search of oil must submit reports including the log of the wells to the board, but the major oil companies who drill 'test wells' and wells for 'information purposes' only are exempt from this provision."

Supporters of the measure, which will now be voted on by the electorate of the state in the fall of 1942, deny Tieszen's charges with the assertion that the law merely provides conservation control and would "have the effect of bringing into South Dakota not only the major oil companies, but dozens of independents and royalty operators."

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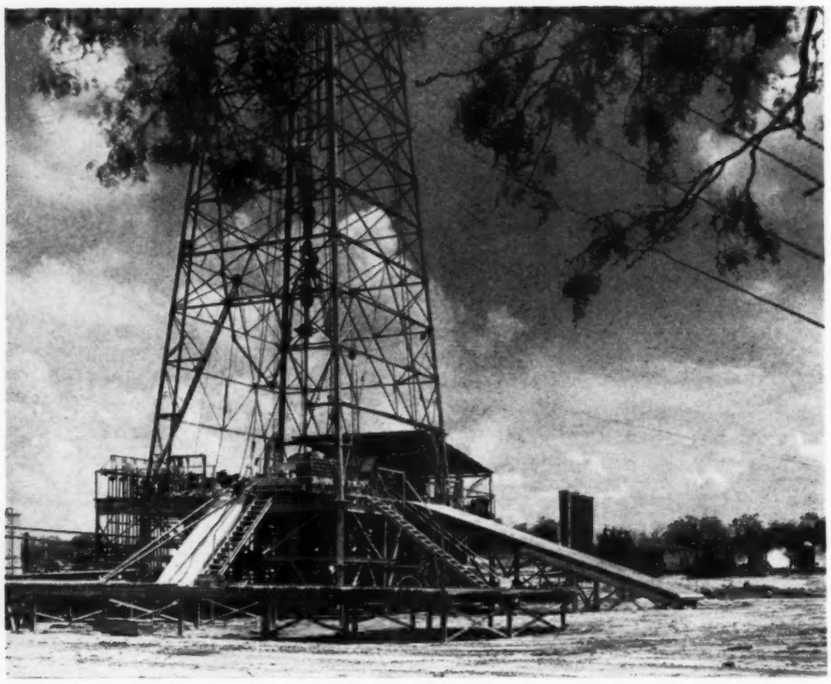


Fig. 1. General view of the derrick and 12-ft. substructure

PETROLEUM ENGINEER Exclusive Feature

by

H. Lee Flood

Associate Editor

Southwest Texas Well Drilled Under Unusually Adverse Conditions

☆ Virtually every device and method developed for high-pressure drilling is employed—abnormally high formation temperature of 268° F. encountered

IT IS generally conceded that oil-well drilling in the Gulf Coast and Southwest Texas areas, considered broadly, presents more unforeseen problems calling for specialized treatment than in any other given area. Greater depths, higher formation pressures and temperatures, often the presence of high-pressure salt water flows, heaving shale and other conditions contributing to hole caving, and many other factors are instrumental in causing nearly every well undertaken to be pretty much of a gamble as to whether it can be successfully completed, irrespective of whether commercial production is found or not.

Some difficult drilling problems have been encountered and solved successfully in the past but what is conceded by many to be one of the most treacherous wells ever drilled in Southwest Texas has only recently been completed and is now being tested.

The account of how this well was successfully completed is all the more remarkable when it is realized that the work was continued after a blowout and fire had created conditions that might usually result in abandoning the well.

In this instance, the fortunate combination of being abreast of modern developments in drilling so the owner of the well was able quickly to determine the proper procedure to follow based on a careful analysis of all the factors involved, plus careful, intelli-

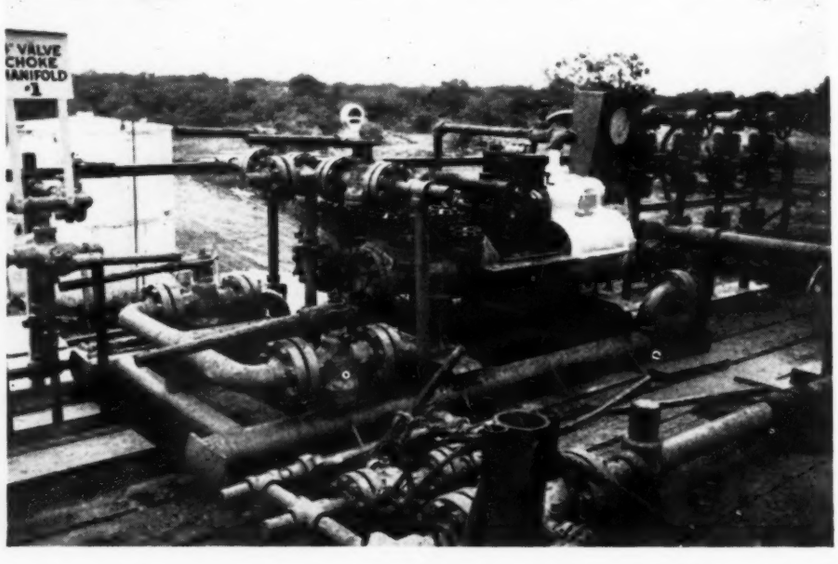


Fig. 2. 8000-lb. high-pressure pump may be compounded to increase mud pressure during an emergency

LOOKIN' FOR TROUBLE!

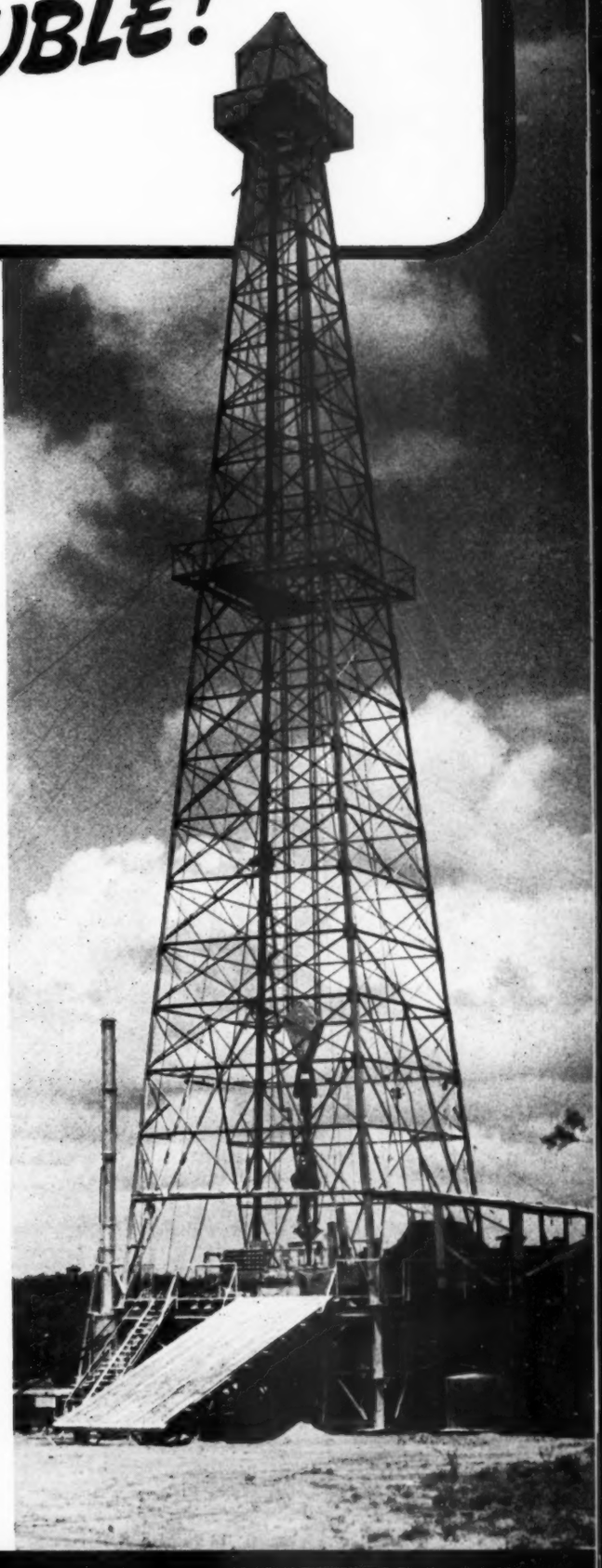
Edwin M. Jones Selects PARKERSBURG For New Super-Duty Rig at George West, Texas

When Edwin M. Jones' 3-B George West deep test in the George West field of Southwest Texas blew out recently and destroyed most of the drilling rig, this operator assembled what is generally regarded as one of the most complete heavy-duty rigs in existence. A new Parkersburg drilling derrick replaced the old Parkersburg derrick which was damaged when a section of drill pipe was blown through its girts. A 5-foot "sub" sub-structure, fabricated to specifications in the Parkersburg shops at Houston, was added to the regular 7-foot sub-structure to permit the use of a special pressure-operated blowout preventer hook-up. Parkersburg pre-fabricated mud tanks were installed to assure accurate mud volume and mud weight control during pressure-drilling operations.

Thus, Parkersburg equipment is playing an important part on this unusual rig of hand-picked equipment . . . a rig that's lookin' for trouble and prepared for it!

THE PARKERSBURG RIG & REEL COMPANY
PARKERSBURG, W. VA.
DALLAS - HOUSTON - TULSA - LOS ANGELES - NEW YORK

Parkersburg Portable Mud Tanks in service on Edwin M. Jones 3-B George West, safeguarding mud weight and volume



PARKERSBURG FAULTLESS FABRICATION

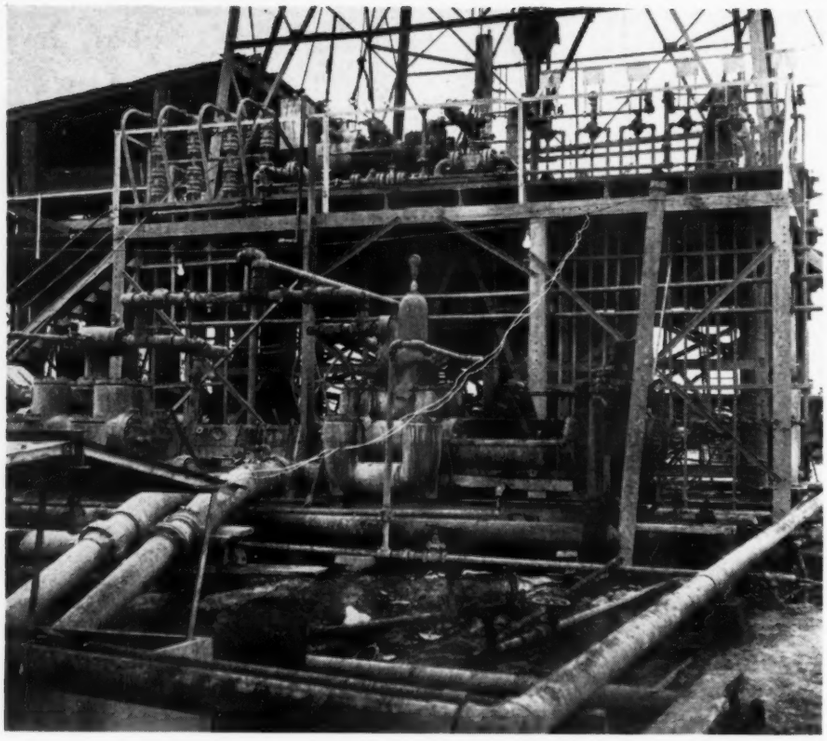


Fig. 3. Showing arrangement of equipment on extension of derrick floor. Choke valves on mud return lines on left, high-pressure pump in center, and hydraulic-operated valve controls on right

gent workmanship by the toolpushers, drillers, and their crew members, can be credited with successful continuation of drilling to completion of a well that might otherwise have caused additional trouble and expense before being forced to abandon the project.

The well in question is the George West No. B-3, drilled by Edwin M. Jones in N. Owen Survey No. 56. The well is situated approximately 4 miles southwest of the town of George West, county seat of Live Oak County, Texas. There was little of special interest in the drilling of this well prior to the time trouble developed. For this reason, only the highlights of the well's history prior to the blowout and fire will be touched upon.

The well was spudded January 6, 1941, and 13⅜-in. casing was set and cemented as a conductor string at a depth of 860 ft., using 1000 sacks of cement. A string of 9⅝-in. casing was set at a depth of 6787 ft. and cemented with 3400 sacks of cement.

When the top of the Carrizo was encountered at a depth of 9039 ft., the drill pipe and bit were removed from the hole in preparation for coring. When the core bit and only 90 ft. of drill pipe had been run back in the hole, the well blew out.

In removing the drill pipe from the well while the hole was bridged momentarily, a spark caused an explosion of considerable force. Fortunately none of those present was injured but the resulting fire burned for 16 hr. before being extinguished. The well was killed by pumping in 100 sacks of cement, forming a plug whose top was at a depth of 4000 ft. Prior to killing the well, it was determined that the gas pressure was approximately 6500 lb. per sq. in.

The intense heat of the fire caused considerable damage but did not cause the derrick to collapse.

In studying the possibility of drilling-out the cement plug without again losing control so that the well might be completed, it was recognized that an excessively heavy mud would be required in the 4000-ft. column in order to withstand safely the high bottom-hole pressure.

Faced with the impossibility of relying only on mud weight in an open hole to withstand the pressure, the ob-

Fig. 4. Mud return lines branch from two 4-in. crosses. Note 4-in. hydraulic-operated valve between crosses and blowout preventers

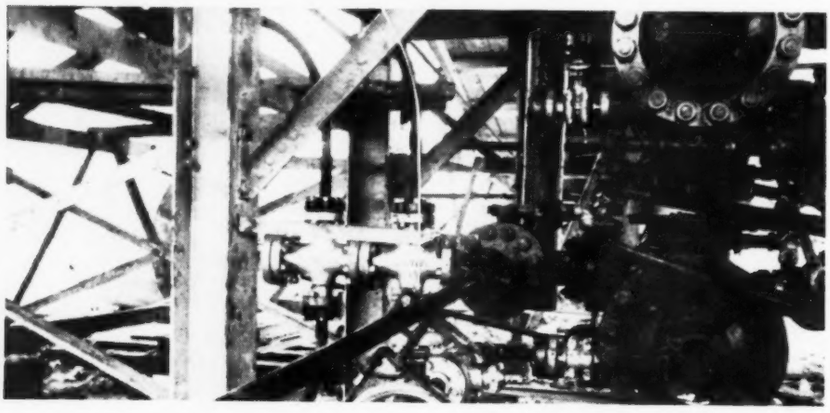
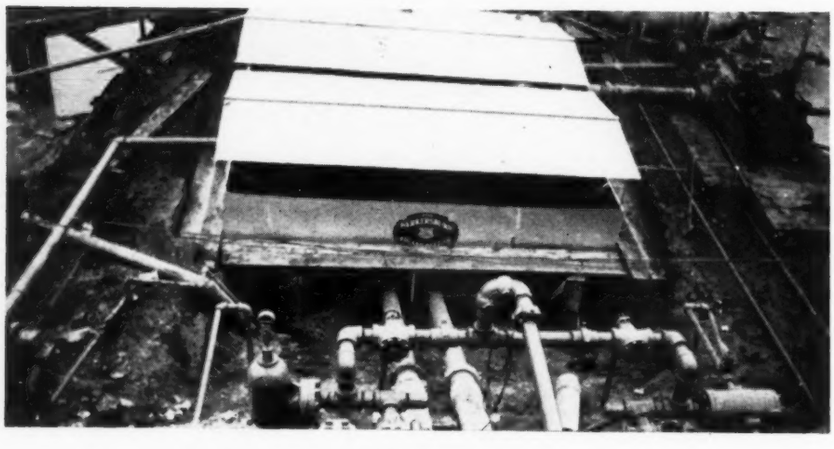


Fig. 5. Steel mud tanks are roofed as protection from rain



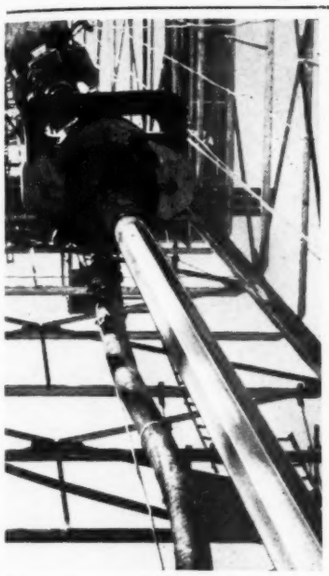
PETROLEUM ENGINEER EDITION

BAASH-ROSS News

A MONTHLY BULLETIN COVERING NEWS OF EQUIPMENT AND OPERATIONS IN THE PETROLEUM INDUSTRY

ENGINEERING FIGURES THAT WILL SAVE YOU MONEY WHEN PURCHASING KELLYS

Do you know the reasons behind the trend to hex kellys for all drilling operations?



There are three types of kellys in general use today—square, hexagonal and octagonal.

Baash-Ross makes all three types... yet, when asked "Which type of kelly is best for modern all-around drilling operations"—in the best interests of our customers, there is only one reply we can truthfully make—*hexagonal!*

Many operators still think of the hexagonal kelly as a "special" type for "special" conditions... such as for drilling under pressure. But, repeated engineering tests... our own field operation records... and performance data from our customers—*all* have proved conclusively that the hexagonal kelly is definitely superior for *every* type of drilling operation.

Briefly, before you buy *any* new kelly equipment, here are the salient points you should know about the hexagonal kelly...

▶ **DEVELOPMENT:** The first polygonal (more than four sided) kelly was an *octagonal* kelly developed to enable operators to drill under pressure through pack-off equipment without tearing the rubbers. Although developed primarily for pressure drilling this kelly showed other promising features and encouraged further research work along this line. The final result of this development work was a kelly combining the best features of *both* the octagonal and square kellys—the *hexagonal* kelly!

The hexagonal kelly quickly forged ahead and subsequently has proved to have so many advantages over the square kelly that many operators are standardizing on the *hexagonal* kelly for ALL of their drilling operations. *We predict that in the near future, the hexagonal kelly will have replaced the well-established square kelly as standard drilling equipment on most rigs. Why?*

▶ **BETTER BALANCE:** Because hex kellys are *machined* to exceptionally close tolerances from solid alloy steel stock, their dimensions are held to much closer limits than is possible with the *forged* construction of square kellys. This, coupled with the unusually true, concentric bore and the accurate joint alignment, results in an almost perfect weight distribution... gives a *smoother* running, better-balanced kelly at *all* drilling speeds. This feature has proved to be particularly important for today's high rotational speeds... and as drilling speeds increase it will assume even greater significance.

▶ **28% STRONGER IN TORQUE:** Since a kelly is primarily a tool for *rotating* the entire drill string, its ability to transmit torque without failure is of great importance. Because of its shape and greater cross-sectional area, *the hexagonal kelly is 28.6%* stronger in torque than a square kelly of comparable cross-corner dimensions.*

▶ **1.8% GREATER TENSIONAL STRENGTH:** Besides *rotating* the drill string, the kelly must also *support* the entire string... which makes tensional strength another important factor to consider. Because of its greater cross-sectional area, the hexagonal kelly, size-for-size, *is 1.8%* stronger in tension than the square kelly!*

▶ **23% MORE RESISTANT TO BENDING:** One of the greatest difficulties in kelly operation is maintaining straightness. Generally, kellys bend while being swung back in the rat-hole... or through improper support when hauled or racked. In either case, the bend nearly always occurs *across the flats.* Hexagonal kellys *are 23.2%* more resistant to bending across the flats than are square kellys*... and are also more resistant across the corners!

Operators who have once tried hex kellys find that the longer life, the greater rigidity, the lower maintenance costs provided by this greater resistance to bending is *alone* sufficient to justify a complete switch to hex kellys for *all* their drilling work.

▶ **48% MORE CIRCULATION AREA:** With today's full-hole pipe and high volume pumps, it is imperative that there be no "bottleneck" where fluid enters the string. In addition to their greater strength, hex kellys have *48%* more circulation area* than the comparable size of square kellys!

Re-check those features and you'll find that the hex kelly equals or surpasses the square kelly on every point... *and, in addition, gives you some very important advantages not obtainable in the square kelly!*

THEN REMEMBER THIS: **You can use the hex kelly for *every* type of drilling operation—*both regular and pressure work* without change!**

Before you invest in any new kelly equipment, find out how little it costs, how much it pays, to use Baash-Ross Hexagonal Kellys. Your Baash-Ross representative will be glad to go over the matter with you... or write us for further information.

*These figures are based on the widely-used 6" square kelly with 3½" bore vs. the 6⅝" hexagonal kelly with 4½" bore. *Because it is the maximum dimension that governs the selection of a kelly size,* the 6⅝" hexagonal (across-corner dimension 7¾") is comparable to—in fact, is actually ⅛" *smaller* in its limiting dimension than the 6" square kelly (across-corner dimension 7⅞"). In other comparable sizes, hex kellys offer proportionate advantages.

ON THE LOOKOUT

A NEW PLAN OF OIL AND GAS PROSPECTING—known as the geodynamic method—was discussed recently in a paper read before the A.I.M.E. This method is founded on the supposition that gas escapes from underground reservoirs to the surface in minute quantities. Measurement of such gas leakage at various points would be used in plotting an outline of an underlying oil or gas accumulation, according to the report.

BAASH-ROSS

A NEW METHOD of protecting Tool Joints against wear has been developed and is showing exceptional savings in field tests. Employs "hard facing" metal similar to that used on drilling bits. Application is simple, tool joint life approximately doubled, and full elevator shoulder is maintained, reports state. (No. C-61)

BAASH-ROSS

A METHOD OF "EAR-MARKING" thin oil zones for more accurate perforation has been developed. Oil zone is marked during or after drilling by firing radioactive bullets into walls. After casing is run, position of these markers can be accurately determined with detecting device, greatly reducing chance of perforating at wrong location. (No. C-63)

For more details, simply send your name, address and key numbers of items that interest you on a post card or letterhead.

Tubing Used to Drill, Then Case, 8200-Ft. California Wells

When tubing is used for drilling *a complete well*—that's news... especially when the well is more than 8200 feet deep. Yet that's exactly what was done on four different wells recently drilled in a California field. And to top it off, the tubing was also used to case the hole on completion of the well.

The tubing was regular 4½ inch upset Acme Thread, having a double seal feature. It received practically the same treatment as drill pipe. The only concession was building up the pipe tongs to provide 12 inches of gripping space. Drilling speed was not reduced—in fact, the 18 days consumed in drilling the first well amounted to only a day longer than the *fastest* time made with drill pipe in the same field.

NO DRIVING "TEAM" CAN EQUAL THIS!

There's no sweeter running combination for rotating a drill string than a *Baash-Ross Hexagonal Kelly* turning in a *Baash-Ross Roller Kelly Bushing.*

The perfect balance... the greater rigidity... the smoother-running performance of the hex kelly, coupled with the frictionless feed of the *Roller* drive bushing, gives complete control over the bit and drill string in *all* kinds of digging... at *all* speeds.

In fact, both the Type 2R*H* Roller Bushing (the type used for hex kellys) and the Type 2RS Roller Bushing (for square kellys) are built to withstand unusually heavy torque loads *and rotational speeds of a thousand r.p.m. and higher.*

That's looking quite a ways ahead. But it's something to know... that for the investment you make in a Baash-Ross Hexagonal Kelly and a Baash-Ross *Roller* Kelly Bushing, *you're getting the latest and most modern equipment you can buy*... equipment that will give outstanding performance on the wells of the *future* as well as today!

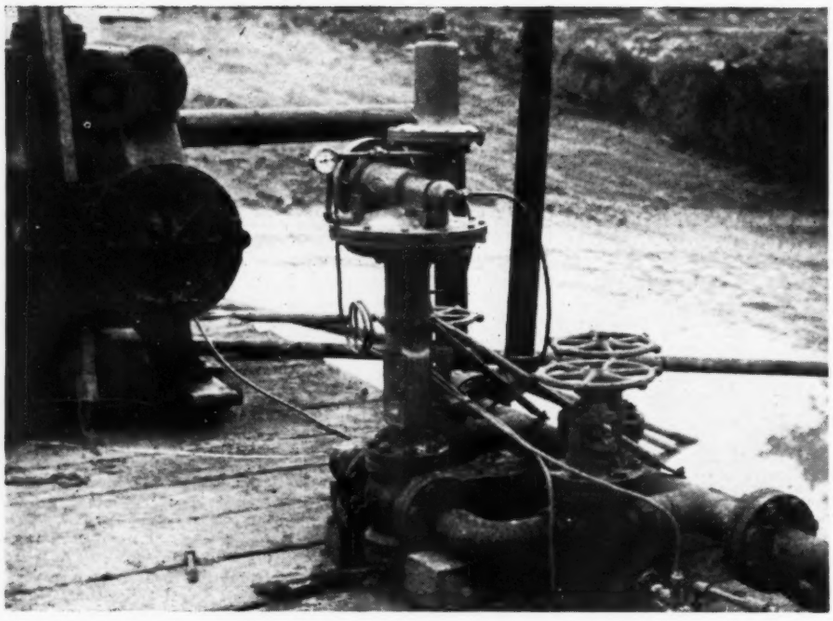


Fig. 6. When mud pressure decreases below a predetermined amount, this control equipment admits steam to auxiliary 18-in. pump "floating" on line

vious solution to the problem was to employ pressure drilling equipment so that additional weight (in effect) could be imposed on the hole by holding back pressure on the mud return line.

Redesigning the Drilling Equipment

In planning the program whereby drilling could be continued against the high pressure and other adverse conditions, a thorough investigation was made of every device and piece of equipment that might conceivably be of use on the well. Other rigs on the Gulf Coast designed for high-pressure drilling were studied and engineers with leading manufacturers and oil companies were consulted.

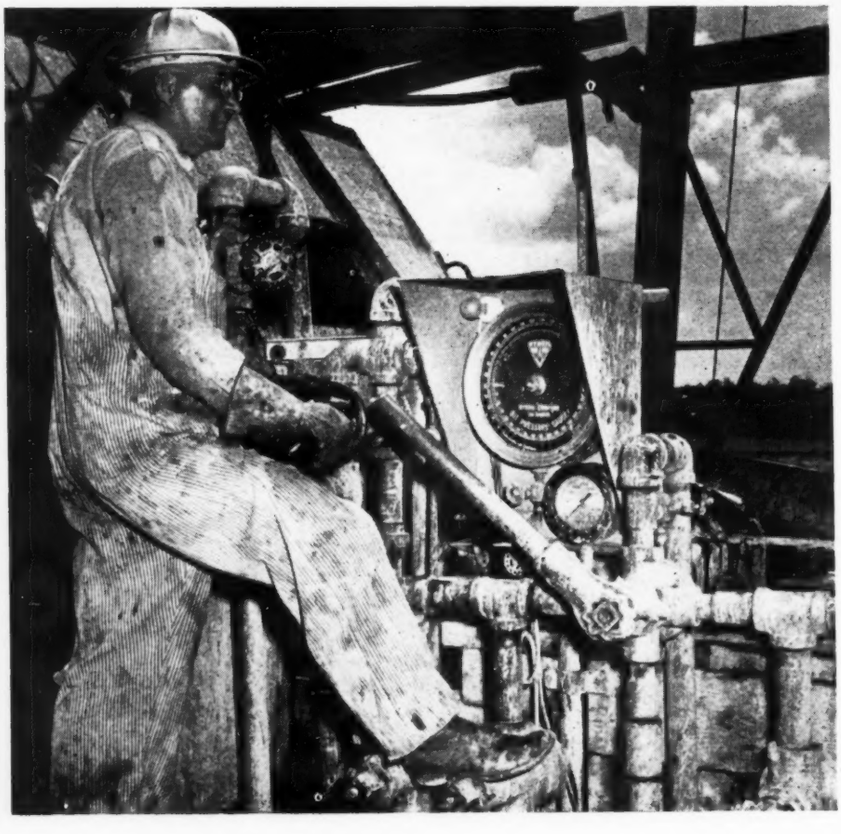
As a result of this thorough study, the drilling equipment was redesigned in such a way that the rig now is undoubtedly one of the most complete ever assembled.

The general plan and arrangement of equipment as finally adopted represented a combination of the best ideas presented by the several designing engineers working on the problem.

Derrick and Substructure

A new 136-ft. derrick was purchased, of the same type that had withstood the fire so successfully, and

Fig. 7. Driller John Rusk at controls of drawworks and hydraulic rotary table



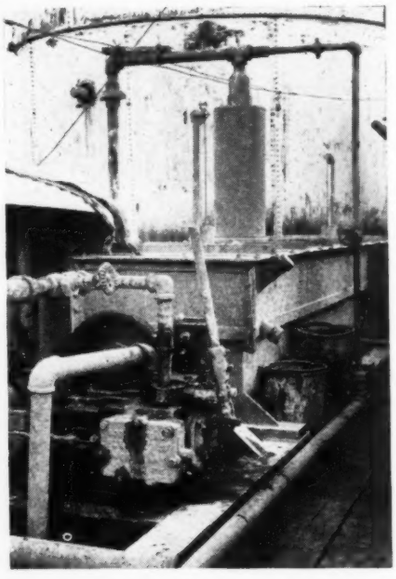


Fig. 8. This degasser churns the mud and exhausts the gases under vacuum

erected on a 12-ft. steel substructure. The higher substructure was required in order to provide additional height for operating the hydraulic table without digging a cellar. Elimination of a cellar was also considered extremely important in order that all equipment below the derrick floor would be readily accessible. The existing 7-ft. substructure was strengthened and extended by adding 5-ft. lengths to all columns. Details of the extended substructure are best observed in Figs. 1, 3, and 13.

In order to place all important valves and drilling controls readily accessible without crowding the 30 ft. by 30 ft. area on the derrick floor, an extension or "balcony" was constructed thus providing additional room on the derrick

Fig. 9. As the variable flow valves on the mud manifold are adjusted, the dual pressure recorder is watched closely

floor level. The 8-ft. by 30-ft. extension was made by lengthening the horizontal floor beams and supporting them adequately. An end view of the balcony may be seen in Fig. 11.

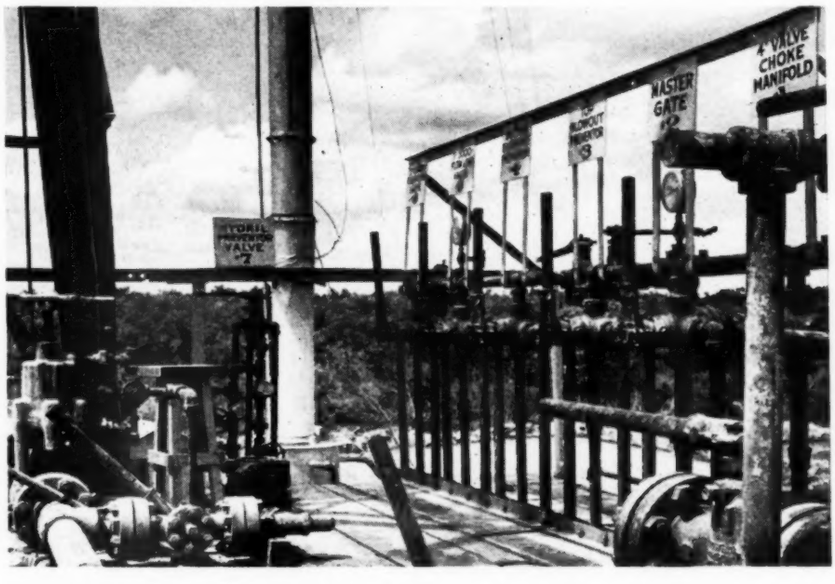
The balcony provides space for the hydraulic-valve controls, shown in Fig. 10; the high-pressure mud pump, shown in Fig. 2, and the variable chokes on the mud return lines and the dual pressure recorder, shown in Fig. 9. The relative arrangement of this equipment is shown in Fig. 3.

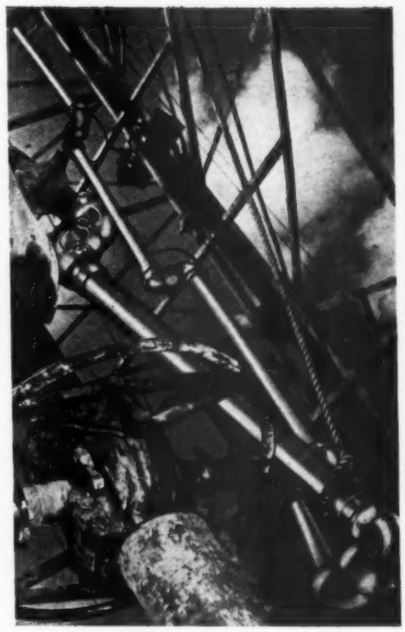
Additional Mud Pumps

The two existing 20-in. mud pumps were considered adequate for normal conditions. Two important additions were made, however, that have proved absolutely essential in adequately controlling the well.

An 18-in. mud pump was installed to serve as a standby, in a sense "floating" on the line so that if the pressure of the mud decreases even momentarily below some predetermined pressure, the pump will begin working and quickly restore the pressure. Steam to the pump is controlled by a diaphragm-operated throttle valve actuated through pressure tubing by the pressure on the mud

Fig. 10. Showing the arrangement of controls governing various hydraulic-operated valves. Hydraulic-operated standpipe valve is shown on extreme left





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THREE-WAY DISC BIT
STANDARD and HEAVY DUTY REAMERS

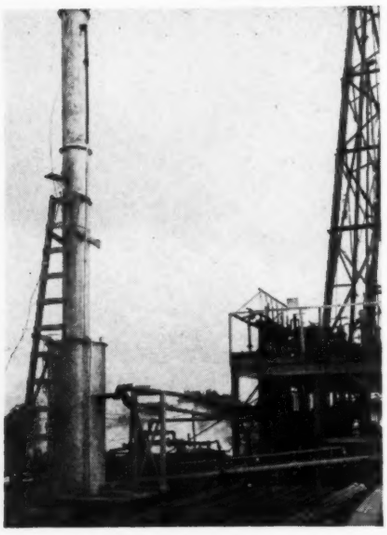

Fig. 11. Vertical degasser removes all free gas from return mud lines

inlet line. The control valve and pilot regulator are shown in Fig. 6.

An additional pump, shown in Fig. 2, was built especially for this job. Its purpose is to provide additional mud pressure by compounding, when the capacity of the two 20-in. and one 18-in. pumps is exceeded. Designed for 8000-lb. service, this duplex pump has 3-in. by 12-in. cylinders on the mud end and 14-in. by 14-in. cylinders on the steam end. Mounted on the balcony, the pump and the control valves in the all-steel manifold may be quickly reached in an emergency.

Circulatory System

The mud discharged by the two 20-in. pumps (or by the high-pressure pump when it is operating) enters the standpipe through a shut-off valve that differs from the usual valve in such service in that it is hydraulically operated for quick closing. All-steel rotary hose connects the standpipe and the swivel.

The mud from the vertical degasser (or from the direct mud line) goes to the shale shaker.

From the shale shaker the mud flows in a wooden trough to the second degasser, shown in Fig. 8.

In the second degasser, the mud is subjected to further breaking-up in order to remove occluded gas and condensate fractions. A steam engine drives a paddle wheel that effectively stirs the mud. The gases are exhausted through the dome under vacuum.

From the second degasser the mud flows into the first of two steel mud tanks, both of which serve as storage for the mud being circulated.

Adequate Controls Provided

Additional controls and gauges not usually found on drilling rigs include the dual pressure recorder shown in Fig. 8. This instrument gives simultaneous readings of the pressures of the mud in and mud out, both on direct reading and recording gauges.

Another unusual recording device is the gauge whereby the level of the mud in the tanks is automatically made known to the driller by means of colored lights mounted above the dual pressure recorder. When the mud level increases or decreases from a fixed point, one or the other of these lights flashes on, thus indicating immediately to the driller whether the volume of mud returned from the hole is greater or less than the volume of mud entering the well. Thus, any tendency of the well to blowout or to take an excessive volume of mud is more quickly indicated.

Fig. 12. Operating snubbing equipment on hydraulic rotary table

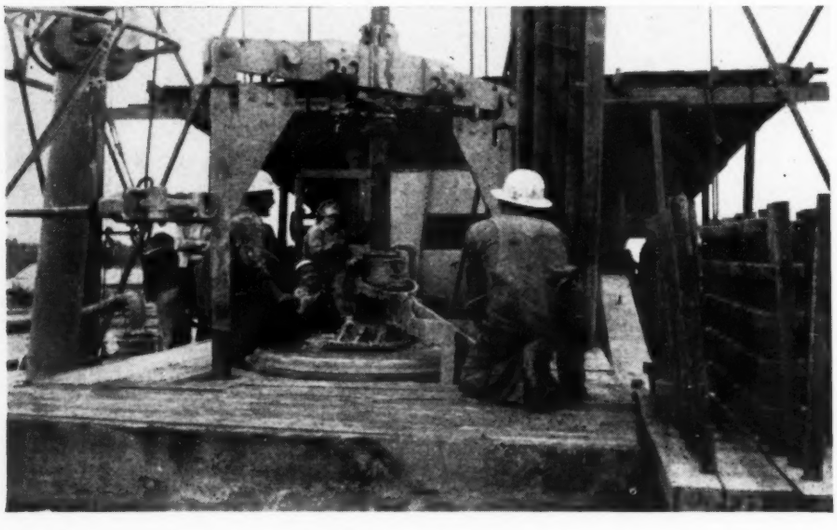

Fig. 13. Showing relative height of substructure above ground level

General

In the foregoing discussion, it has been possible to describe briefly only a few of the more unusual features on the George West B-3 well.

A noticeable feature of the entire assembly is the attention that has been devoted to providing safe working conditions for the drilling crews.

Likewise, considerable space could be devoted profitably to a discussion of the problems involved in the chemical treatment of the mud used in this well. Among other conditions, mud control was made exceedingly difficult because of the abnormal temperature of 268°F. encountered in this well.

As mentioned earlier, this well was completed under difficulties that in most instances would have seemed insurmountable.

After the 5½-in. casing string had been set at a depth of 9733 ft. and cemented to the surface using 2500 sacks of cement, testing of all promising formations was begun. Although the testing has not yet been completed, it is expected that the work will be finished by August 1.

Adequate records were kept during drilling so that a study could be made of the relative progress through various formations. An unusually complete set of formation samples was procured, accurately tied-in as to depths. These, together with core data, have made it possible to construct a log that is exceptionally accurate. All information available to date, including the results of such tests that have been made, indicate that the total of oil-saturated sections in the Carrizo and Wilcox formations is greater than 300 ft.

Specified Formulas for the Practical Engineer

by Frank R. Young
Consulting Petroleum Engineer

Pump and horsepower relationships reviewed and clarified

ALMOST every engineer, in the course of his practice, accumulates a file of formulas, tables, notes, and graphs that he uses as "short cuts" in the solution of routine problems. Without minimizing in any way the importance of fundamental engineering principles, these short-cut formulas should be entitled to their place in engineering literature if for no other reason than time saving alone. Many problems, of course, that contain a number of variables do not lend themselves readily to simplification but in the field of petroleum engineering, certain problems are basic, owing to the nature of the oil business and many of them can be reduced to simple terms.

Engineering, like most other professions, can be classified into two separate and distinct branches, theoretical and practical. Under theoretical engineering we find the teachers, the research workers, and the scientists who, in order to carry out their work, must deal primarily in fundamentals. On the other hand, the practical operating engineer who is engrossed in keeping the wheels turning, may not be, and often is not, a good mathematician.

Consequently, it has been the experience of most engineers to lose contact to a certain extent, with what we may call scientific engineering principles and to develop, over a period of years, a file of "pet" formulas for reducing the labor of frequently-used calculations.

Empirical or short-cut formulas, to be used intelligently, should of course be understood by the user. That is, they should not be so symbolized that their basic derivation is obscured, otherwise the user might insert improper values and obtain the wrong answers. The examples and discussions that follow are from the writer's files and they may suggest to other engineers a condensation as it were of other formulas and methods of calculations.

Pumping Calculations

One of the more frequent operations in the oil industry is that of pumping either oil, water, or gasoline. A pumping problem is usually expressed in quantity (gal. per min. or bbl. per day) and in either lb. pressure or ft. head. We may convert pressure to ft. head and vice versa by these formulas:

Feet head $\times$ 0.433 = lb. pressure per sq. in.

Pounds pressure per sq. in. $\times$ 2.31 = ft. head.

These formulas are developed as follows:

A column of water 1 in. sq. and 1000 ft. high, weighs:

$$\frac{12{,}000 \text{ cu. in. water}}{1728 \text{ cu. in./cu. ft.}} = 6.944 \text{ cu. ft.}$$

$\times$ 62.35 lb./cu. ft. = 432.96 lb. of water.

$$\frac{433 \text{ lb.}}{1000 \text{ ft.}} = 0.433 \text{ lb. pressure per ft. head. Or,}$$

$$\frac{1000 \text{ ft.}}{433 \text{ lb.}} = 2.3095 \text{ or } 2.31 \text{ ft. head per lb. of pressure.}$$

FRANK R. YOUNG

after serving with the A. E. F. as a second lieutenant in France entered the oil industry in the Burkburnett field, Texas, in 1919—Followed several years oil-field engineering and construction in Texas and Louisiana—In 1924 was resident engineer on General Petroleum Company's marine loading terminal at San Pedro, California, after which he was 8 years with Shell Oil Company at Los Angeles, the last 4 years as assistant superintendent of pipe lines—Three years with Richfield Oil Company as cost and industrial engineer in their California refinery and pipe-line departments—Since 1936 has been on production engineering and development work in Kansas, Illinois, and Indiana.

Pump Horsepower Calculations

Problem: It is desired to pump 500 gal. of water per minute at 300 lb. per sq. in. pressure. What is the required horsepower?

The basic formula for calculating horsepower is:

$$\text{hp.} = \frac{\text{weight in lb.} \times \text{height in ft.}}{33{,}000}$$

This formula necessitates reducing the problem to weight and ft. head. A shorter way to make this calculation is:

$$\text{hp.} = \frac{\text{gal. per min.} \times \text{lb. pressure}}{1713} \text{ or,}$$

$$\text{hp.} = \frac{\text{gal. per min.} \times \text{ft. head}}{3957}$$

These formulas are derived from the weight of water (1 gal. = 8.34 lb.) in relation to 1 hp. (33,000 ft-lb.) thus:

$$\frac{33{,}000}{8.34 \text{ lb.} \times 2.31 \text{ ft. head/lb.}} = 1713$$

$$\text{and,} \frac{33{,}000}{8.34 \text{ lb./gal.}} = 3957$$

Now suppose we are pumping oil or gasoline instead of water. It may seem reasonable to assume that less horsepower will be required for pumping the same amount of oil at the same pressure because oil is lighter than water. This is not the case, however. If the quantities and pressures are the same, the horsepower requirements will be just the same, regardless of whether we are pumping water or a light gasoline. In the examples next given, it will be noted that the differences in weight (specific gravity) cancel out. Taking again the problem 500 g.p.m. at 300 lb. pressure,

Weight of water: 8.34 lb./gal. $\times$ 7.481 gal./cu. ft. = 62.4 lb./cu. ft.

Weight of oil: 30° A.P.I. = 0.8762 sp. gr. = 7.296 lb./gal.

300 lb. pressure $\times$ 2.31 = 693 ft. head.

Using the basic horsepower formula:

$$\text{hp.} = \frac{\text{weight in lb.} \times \text{height in ft.}}{33{,}000}$$

we have:

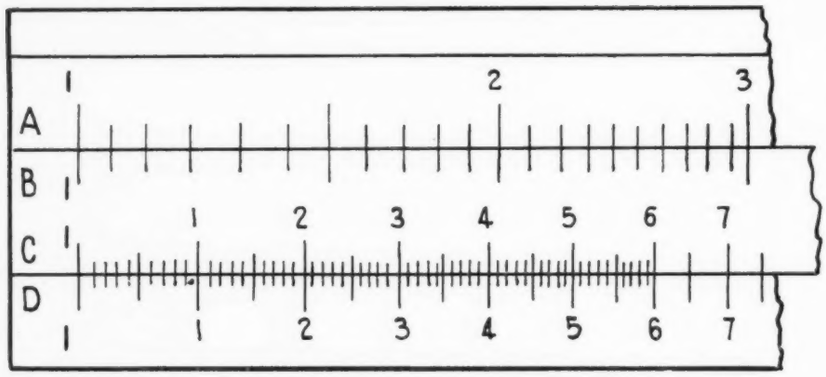

Fig. 1. Showing the slide-rule scale designations adopted in the text

$$\text{Water: } \frac{500 \text{ g.p.m.} \times 8.34 \text{ lb.} \times 693 \text{ ft. head}}{33{,}000} = 87.57 \text{ hp.}$$

$$\text{Oil: } \frac{(500 \text{ g.p.m.} \times 8.34 \text{ lb.} \times 0.8762 \text{ sp. gr.})\ (300 \text{ lb.} \times \frac{2.31}{0.8762})}{33{,}000} = 87.57 \text{ hp.}$$

Now by our short formula, disregarding specific gravities of fluid, we have:

$\frac{500 \text{ g.p.m.} \times 300 \text{ lb.}}{1713} = 87.57$ hp. or,

$\frac{500 \text{ g.p.m.} \times 693 \text{ ft. head}}{3957} = 87.57$ hp.

Pumping Efficiency

The horsepower determined above is not the required horsepower to do the work specified but is the theoretical or "water hp." In order to determine actual required, we shall have to take into consideration the losses in the pump and prime mover. In general, the term efficiency may be defined as the ratio of useful work performed by a prime mover to the energy expended, or output hp. divided by the input hp.

$\frac{\text{hp. output}}{\text{hp. input}} \times 100 =$ efficiency percent,

from which:

$\frac{\text{water hp.}}{\text{Efficiency percent}} =$ actual hp. required

Taking our problem of 500 g.p.m. at 300-lb. pressure, we show 87.57 water hp. If the pump were motor-driven and the motor efficiency was 92.5 percent and the pump efficiency was 71.6 percent, then:

$\frac{87.57}{0.716 \times 0.925} = 132.3$ actual hp. required.

Electric Power for Pumping

When the pumping pressure, quantity, and overall efficiency are known, the power in kw-hr. can be calculated from the following formula:

$$\text{Kw-hr. per 1000 gal./hr.} = \frac{\text{lb. pressure} \times 0.0073}{\text{pump efficiency} \times \text{motor efficiency}}$$

Example: It is desired to pump 500 g.p.m. at 300 lb. pressure. The pump efficiency is 71.6 percent; the motor efficiency is 92.5 percent. How much energy in kw-hr. is required?

$\frac{300 \text{ lb.} \times 0.0073}{0.716 \times 0.925} = \frac{2.19}{0.662} = 3.308$

500 g.p.m. $\times$ 60 min. $= \frac{30{,}000}{1000} = 30.$

$30 \times 3.308 = 99.24$ kw-hr.

Determination of Pump Capacity

Given: Input hp.
Efficiency percent
Pump pressure

From the foregoing horsepower formulas, we derive:

$$\text{Input hp.} = \frac{\text{g.p.m.} \times \text{lb. pressure}}{1713 \times \text{efficiency}}$$

which gives:

$$\text{Capacity in gal. per min.} = \frac{\text{Input hp.} \times 1713 \times \text{efficiency}}{\text{lb. pressure}}$$

Example: Input: 132.3 hp.
Efficiency: 66.2 percent overall
Pressure: 300 lb. per sq. in.

$$\frac{132.3 \text{ hp.} \times 1713 \times 0.662}{300 \text{ lb.}} = \frac{150{,}000}{300} = 500 \text{ g.p.m.}$$

From this example, several other formulas are suggested, with given conditions changed.

Gas Engine Horsepower

The power delivered by a gas engine depends on so many variables that it is impossible to calculate the power exactly by any short formula. The most satisfactory way to determine the horsepower output is to test it on the "brake" or have it drive a known load. The factors that determine the horsepower of a gas engine, include:

Cylinder displacement.
Compression pressure.
Atmospheric pressure.
Spark intensity.
Valve and spark timing.
Size of valves.
Piston velocity (r.p.m.).
B.t.u. of fuel.
Air humidity.
Fuel/air proportion.
Engine load,
and other factors.

It is evident from these factors that on engines of different types and proportions and working under different conditions, a variety of results will be produced that cannot be taken into consideration in any simple formula where close figures are needed.

Following is a formula that will give approximate results that are of value in comparing the horsepower capacities of similar types of engines working under similar conditions. For a stationary, 4-cycle gas engine:

$$\text{hp.} = \frac{DLRN}{13{,}300}$$

in which:

D = Cylinder diameter in inches.
L = Length of stroke in inches.
R = Speed in r.p.m.
N = Number of cylinders.

To obtain S (piston speed in ft. per min.) multiply R times twice the length of stroke in inches, the product being divided by 12, thus:

$$S = \frac{R2L}{12} = \frac{RL}{6}$$

If the gas consumed by a gas engine is 10 cu. ft. per b.hp-hr. (this should be a fair average) it will consume about 14 cu. ft. per kw-hr.

Cooling Water for Gas Engines

A short formula for calculating the cooling water required for gas engines is as follows:

$\frac{500}{\text{Mean temp. difference}} \times (\text{b.hp./hr.}) =$ gal. per hr. required.

Example:
Water out at 100°F. (recommended)
Water in at 80°F.
20°F., MTD (mean temp. difference)

For a 200-hp. engine, we have:

$\frac{500}{20}(200 \text{ hp.}) = 5000$ gal. per hour required.

TABLE I
Piston speeds for normal pump speeds

Stroke, in.	3	4	6	8	10	12	15	18	24	30	36
Pump speed, r.p.m.	72	66	59	45	40	40	40	40	35	30	26
Piston travel, ft. per min.	36	44	52	60	75	80	100	120	130	150	156

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"Flu-Ring" and "Flu-Cup" pumps are available in a wide range of sizes, and in types which include either stationary or traveling barrels, and top or bottom anchoring. Ask your nearest Fluid Packed representative for the details on this outstanding new line of low-priced precision pumps—or write us direct!

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Traveling Barrel—Bottom Anchor

Blower Horsepower

The horsepower requirement for blowers or exhausters can be calculated from the following formula:

Brake hp. =

$$\frac{D \times \text{r.p.m.} \times 0.08 \times P \times \frac{144}{0.08}}{33{,}000 \times \text{efficiency}}$$

in which:

D = Displacement in cu. ft. per revolution.

r.p.m. = Actual speed in revolutions per minute.

P = Pressure in lb./sq. in.

0.08 = Weight of air in lb. per cu. ft.

$\frac{144}{0.08}$ = 1800 = ft. head equivalent to 1 lb. per sq.in.

Efficiency = 92 percent or 0.92 (normal mechanical efficiency)

For gas, the factor 0.08 would be larger or smaller, depending on specific gravity, but as this factor cancels out, the result is the same as for air.

Steam Engine Horsepower

The usual formula for calculating the horsepower of an ordinary double acting engine, is:

$$\text{hp.} = \frac{2PLAN}{33{,}000}$$

in which:

P = Mean effective pressure in lb. per sq. in.

L = Length of stroke in ft.

A = Area of piston in sq. in. = $0.7854\ D^2$

N = Number of revolutions per minute.

D = Diameter of piston.

This formula, reduced to lowest terms, becomes:

$$\frac{2 \times P \times \frac{L}{12} \times 0.7854 \times D^2 \times N}{33{,}000} = \frac{0.1309 \times PLD^2N}{33{,}000}$$

$= 0.000003967\ PLD^2N = \text{hp.}$

or, the decimal 0.000004 may be used with only about 1 percent error.

TABLE 2

Pump constants

Imp./rev. / Gal./min.	1 / 7.17	2 / 5.07	3 / 4.15	4 / 3.57	6 / 2.92

Reciprocating Pump Calculations

Many problems arise concerning the pressures and capacities of steam pumps. A little practice on the slide rule will allow the engineer to solve many of these problems in a fraction of the time required by the usual method.

Determining Pump Pressures

Take an ordinary slide rule and designate the four scales as in Fig. 1.

Let the four scales of the slide rule represent the following values:

A = Discharge pressure.

B = steam pressure × 70 percent.

C = Fluid cylinder diameter, in.

D = Steam cylinder diameter, in.

Now, with any three conditions known, the fourth can be found with only one slide rule setting. For example:

What is the discharge pressure of a 12 in. by 4 in. by 12 in. duplex double-acting pump?

On scale D set 12 as the steam cylinder diameter in inches and over 12, set 4, the fluid cylinder diameter. Then above 87.5 on the C scale (87.5 is 125 lb. steam pressure × 70 percent) read 786 lb. on the A scale, which is the discharge pressure of the pump. Or, with the discharge pressure, steam pressure, and fluid cylinder diameter known, the required steam cylinder diameter can be found with one slide rule setting.

Pump Capacities

Again referring to the slide rule, the capacity in gallons per minute of a pump can be found as follows:

Scale values.

A = Capacity in gal. per min.

B = Piston speed, ft. per min. (from Table 1).

C = Constant (from Table 2).

D = Fluid cylinder diameter, in.

Using the same 12 in. by 4 in. by 12 in. pump, we find from the table under 12-in. stroke, a piston speed of 80. The pump has 5 impulses per revolution, so from the table of constants, we find C equals 3.57. Now we set the slide rule as follows:

D = 4 and above 4 we set,

C = 3.57 and above

B = 80, we read

A = 100, which is the capacity of the pump in gal. per minute.

The many types and kinds of pumps now on the market, enable the operating engineer to select almost exactly the one he needs for any particular job. The writer has found Table 3 convenient for quickly determining the size and type of pump needed for a certain performance. The usual requirement that an engineer has is gal. per min. or bbl./hr. and some approximate line pressure to meet. In using Table 3, first select the quantity needed, then find the pump pressure most nearly corresponding to that required, then the other information is readily at hand. A simplex pump performance may be determined from the table also, keeping in mind that the table shows the characteristics of a double acting-duplex unit.

TABLE 3

Reciprocating steam pumps—Duplex-double acting

Size of pump, in.	Kind	Rated working pressure, lb. per sq.in.	Pump speed, r.p.m.	Piston speed, ft./min.	Gal. per min.	Bbl. per hr.	Discharge pressure at 125 lb. steam pressure	Weight, lb.
3 x 2 x 3	Piston	200	72	36	11.2	16.1	197	175
3½x 2¼x 4	Piston	200	66	44	17.4	24.9	212	200
4½x 2¾x 4	Piston	200	66	44	26.0	37.2	234	380
5¼x 3½x 5	Piston	200	59	39	37.3	53.4	197	560
4½x 3¾x 4	Piston	75	66	44	48.3	69.2	126	410
7½x 3 x10	Piston	500	45	75	52.7	75.5	546	1125
10 x 3 x10	Piston	650	45	75	52.7	05.5	972	2280
6 x 4 x 6	Piston	200	52	52	65.0	93.0	197	650
7½x 3½x10	Piston	500	45	75	71.8	102.5	402	1125
10 x 3½x10	Piston	800	45	75	71.8	102.5	714	2450
10 x 3½x12	Piston	800	40	80	76.6	109.5	714	2450
12 x 3½x12	Plunger	900	40	80	76.6	109.5	1028	4700
5¼x 4¾x 6	Piston	75	52	52	91.6	131.0	106	630
7½x 4 x10	Piston	200	45	75	93.8	134.0	307	1125
10 x 4 x10	Piston	800	45	75	93.8	134.0	546	2450
10 x 4 x12	Piston	800	40	80	100.0	143.0	546	2450
12 x 4 x12	Plunger	900	40	80	100.0	143.0	786	6100
7½x 4½x10	Piston	200	45	75	119.0	170.0	242	1225
10 x 4½x10	Piston	800	45	75	119.0	170.0	433	2450
10 x 4½x12	Piston	800	40	80	126.8	181.0	433	2450
12 x 4½x12	Plunger	600	40	80	126.8	181.0	622	4700
14 x 4½x12	Plunger	600	40	80	126.8	181.0	846	5000
6 x 5¾x 6	Piston	75	52	52	134.5	192.0	95	860
7½x 5 x10	Piston	200	45	75	146.5	209.0	197	1430
9 x 5 x10	Piston	200	45	75	146.5	209.0	283	1670
14 x 5 x12	Plunger	900	40	80	156.0	223.0	685	7300
7½x 5¼x10	Piston	200	45	75	161.5	231.0	178	1300
9 x 5¼x10	Piston	200	45	75	161.5	231.0	257	1525
7½x 6 x10	Piston	200	45	75	211.0	301.5	136	1300
9 x 6 x10	Piston	200	45	75	211.0	301.5	197	1525
10 x 6 x10	Piston	200	45	75	211.0	301.5	243	1925
10 x 6 x12	Piston	200	40	80	225.0	322.0	243	2075
18 x 5 x18	Plunger	1000	40	120	234.0	335.0	1130	15,500
7½x 7 x10	Piston	200	45	75	287.0	410.0	100	1300
9 x 7 x10	Piston	200	45	75	287.0	410.0	144	1525
10 x 7 x10	Piston	200	45	75	287.0	410.0	178	1925
10 x 7 x12	Piston	200	40	80	306.0	438.0	178	2075
9 x 8½x10	Piston	75	45	75	423.0	606.0	98	2060
10 x 8½x10	Piston	100	45	75	423.0	606.0	121	2780
8 x 9 x12	Piston	100	40	80	506.0	724.0	69	3500
10 x 9 x12	Piston	100	40	80	506.0	724.0	108	3600
12 x 9 x12	Piston	100	40	80	506.0	724.0	155	3700
12 x11 x12	Piston	100	40	80	756.0	1080.0	103	5400

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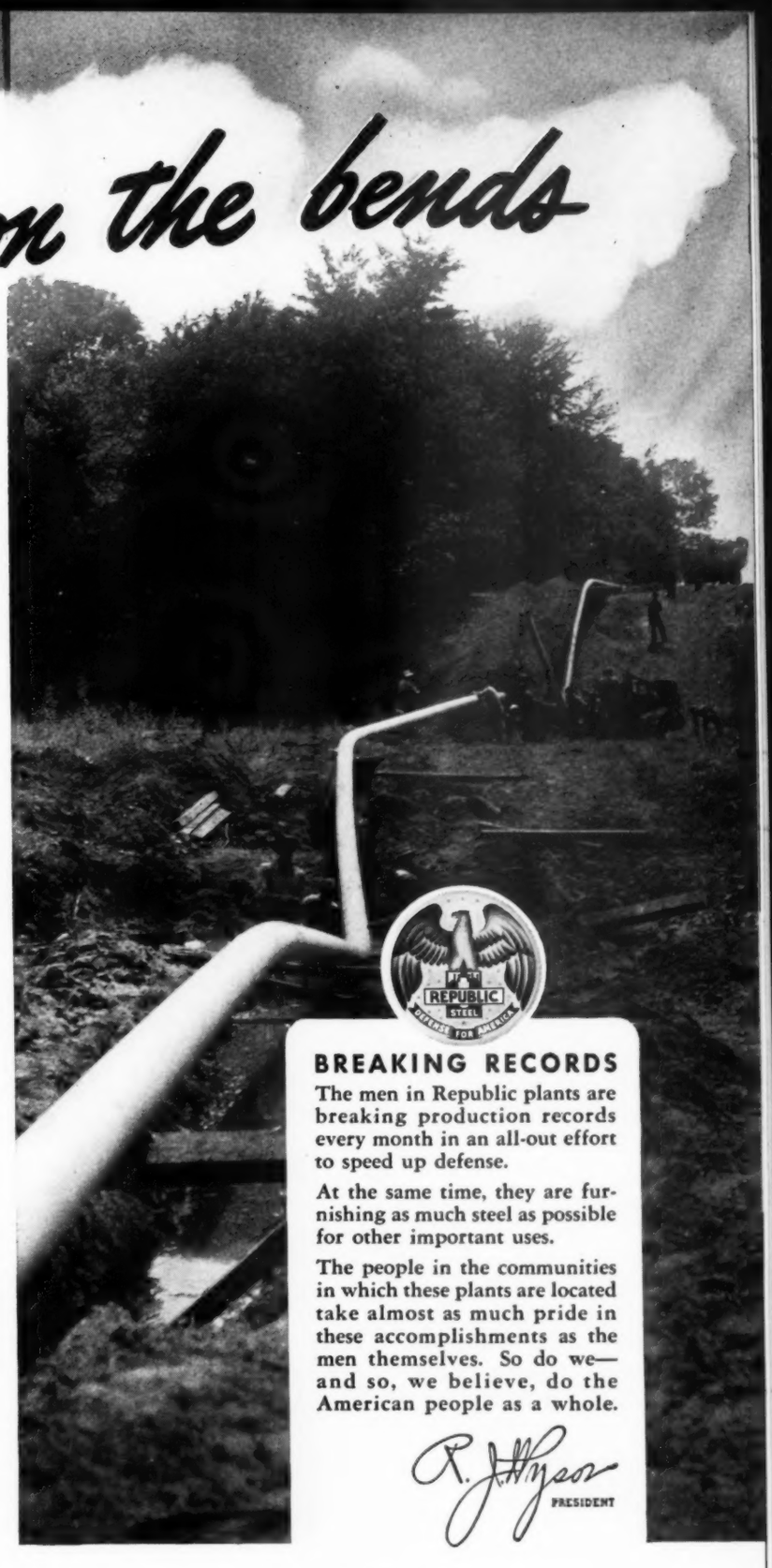

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PETROLEUM ENGINEER Exclusive Feature

PART 3 (Concluded)

by Gordon N. Scott

Consulting Pipe Line Technologist

A photograph and biographical sketch of the writer can be found on page 27 of the May issue of *The Petroleum Engineer* in connection with Part 1 of this article.

ROUGHLY, the percentages of the groups of coatings to which the methods outlined in this article would seem to have application and which would likely fail to respond to the rule of thumb criterion, are given in the table below for the 1934 and 1940 inspections, at which time the coatings had been in service approximately 4 and 10 years, respectively.

Percent of A.P.I. test coatings of certain coating groups having large coating conductance-soil resistivity products

	Inspections	
	percent	*percent*
Coating group	1934	1940
Cold applications	41	70
Enamels	35	53
Shielded	5	32
Reinforced	3	29
Shielded, reinforced	0	19
Mastics	0	0

From a glance at this table it appears that a coating of almost any composition and structure with the exception of mastic after a service life of 10 years would develop sufficient conductance to warrant under cathodic protection more detailed tests than are normally made and it would be best to view the customary criterion of protection in these cases with some suspicion.

Discussion and Conclusion

From a practical standpoint we are interested in knowing when the soil gradients may be disregarded with justification. Obviously the answer to this problem depends on what constitutes a satisfactory potential reading. If 5 or 10 mv. is considered significant, then for bare pipe the gradients in the conductive medium cannot be ignored except possibly in sea water. If the pipe line is treated (coated), generalization is quite difficult as the actual current density requirements are not precisely established within the range where the potential criterion becomes applicable in the practical sense. In this connection, however, some speculative use may be made of equation (35).

The writer has attempted to evaluate the current densities corresponding to certain potential readings in the case of well-treated pipe but as yet no quantitative assertions are ventured. It appears, however, that in some cases current densities on coated pipes are surprisingly high under moderate protective voltages ranging as they do from 20 to 200 milliamp. per sq. ft.

It is evident from an inspection of any of the current density equations in K that if i is to be evaluated then ρ must be known. This latter quantity is difficult to measure for reasons explained. Also in the case of galvanic currents radially entering or leaving the pipe there is considerable asymmetry in the intensity of the current. Furthermore, the theory assumes the coating is uniformly conducting, which in many cases must depart radically from the true state of affairs. The writer's tests have largely been limited to coatings possessing some amount of conductance and the methods have not been tried on highly insulating coatings. Notwithstanding these departures from the ideal conditions assumed and the difficulties in measurement, the theory yields results of considerable practical significance.

It would be convenient if i were nearly or even roughly proportional to ρ as then the earth gradient would be proportional to i, and ΔV_{xh} would serve as a criterion of protection. But this simplicity, except under some circumstances, is entirely too much to expect.

In general, V refers to a potential measured between the pipe and some point in a conducting environment that is in contact with an arbitrary reference electrode. The quantities to which the prime sign is affixed serve to differentiate the potentials due to an external source of current from the normal earth currents.

The delta quantities indicate differences in potentials either due to a change in current, identified by the subscript i, or occurring between two electrodes in some geometrical configuration identified by subscripts indicative of the geometrical limits. The delta squared quantities indicate changes in potential due both to changes in current and to geometrical factors. For consistency the subscript i is used in many cases where it might be omitted but it is always useful to identify the geometrical limits.

The measurement of V depends in part upon the potential of the electrode itself and its reproducibility. The differences in potential (the delta quantities) are independent of the electrode potential but depend on reproducibility, a dependency that may be avoided by interchanging the electrodes. Where measurements are made from time to time, however, it is quite necessary that the electrodes have always the same potential. The change in potentials (the delta squared quantities) are independent of both electrode potentials and reproducibility. It is also apparent that whether the changes in V_a can be ignored may a be function of the personal equation in view of the fact that V_a is related to time and hence the interval of current interruption or application may affect the results.

One of the greatest difficulties confronting the corrosion engineer is to obtain good and sufficient data. Good data are often difficult to record because of sampling difficulties as was illustrated in the case of soil resistivity. Sufficient data are tedious and costly to obtain as was illustrated in Table 3. But usually the value of the pipe line concerning which the tests are made and the ever-present hazards of pipeline failure due to corrosion, surely justify considerably more detailed testing than has heretofore been the practice.

APPENDIX

Symbols and Units

(1) ***Physical quantities, numbers, and constants***

PUMPERS THAT FIT THE LOADS AND CONDITIONS

Insure Lower Lifting Costs

TWO *NEW* NATIONAL UNIT PUMPERS FOR THE SHALLOWER FIELDS...

● The Type TU164-HD16TB has Sykes Herringbone Steel Reduction Gears, Anti-friction Bearing throughout, Service Brake, and Walking Beam Adjustment. As illustrated, it is equipped with National Type B Eccentric Cranks and Counterweights. It is also available with plain type Cranks and Beam Counterweights. When furnished with this equipment it is known as Type TU164G-HD16TP.

The Type TU24G-JD2TP is a Twin Crank Unit for the lightest pumping service. It has Helical Steel Reduction Gears Anti-friction Bearings throughout and Walking Beam Adjustment.

BRIEF SPECIFICATIONS	TU24G-JD2TP	TU164G-HD16TP	TU164-HD16TB
API Walking Beam Rating, Pounds	3200	8900	8900
Polished Rod Strokes, Inches	12½-14-16	26-29-34	22-28-34
Max. Counterweight Effect at Max. Polished Rod Stroke, Pounds	2476	6473	4860
Peak Torque Rating at 20 SPM, Inch lbs.	6360	40200	40200
Overall Gear Ratio	26.0	29.2	29.2
Pitch Diameter of V-belt by Belt Section, Inches	12x2A	18x3C	18x3C
Well End Working Centers, Inches	24	51	51
Walking Beam Size and Weight, CB Section	6x12 lbs.	12x36 lbs.	12x36 lbs.

THE NATIONAL LINE OF UNIT PUMPERS IS SO COMPLETE THAT IT IS EASY TO SELECT THE UNIT THAT IS MOST EFFICIENT FOR THE JOB

TYPES FOR LIGHT TO MEDIUM SERVICE

BRIEF SPECIFICATIONS

	TU24G-JD2TP	TU44G-HD4TP	TU104G-HD10TP	TU164G-HD16TP	*TU164-HD16TB	TU234G-JD23TP	*TU234-JD23TB	*TU304-HD30TB
API Walking Beam Rating, Inches	3200	4300	6725	8900	8900	9125	9125	12750
Peak Torque Rating, Inch lbs. at 20 SPM	6360	11050	24300	40200	40200	57200	57200	76500
Overall Gear Ratio	26.0	29.5	29.2	29.2	29.2	29.8	29.8	29.6
Max. Polished Rod Stroke, Inches	16	20	28	34	34	42	42	48

*Equipped with National Eccentric Cranks and Counterweights—other sizes have beam type Counterweights.

TYPES FROM MEDIUM TO HEAVIEST SERVICE

BRIEF SPECIFICATIONS

	TU464-H46TB	TU603-H60T	TU603-H80T	TU803-H80T	TU805-H110T
Single Reduction Types					
Double Reduction Types	TU464-HD46TB	TU603-HD60T	TU603-HD80T	TU803-HD80T	
API Walking Beam Rating, lbs.	15000	18850	18750	24000	24000
Single Reduction Type:					
Peak Torque Rating, Inch lbs. at 20 SPM	124000	170000	238000	238000	303000
Overall Gear Ratio	10.2	9.7	9.4	9.4	9.32
Double Reduction Type:					
Peak Torque Rating, Inch lbs. at 20 SPM	113000	139000	200000	200000	—
Overall Gear Ratio	30.8	26.8	28.3	28.3	—
Maximum Polished Rod Stroke, Inches	54	54	64	72	72

All the above types have National Eccentric Cranks and Counterweights.

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•

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TOLEDO, OHIO

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TORRANCE, CALIF.

NATIONAL

THE NATIONAL SUPPLY COMPANY

EXPORT

THE NATIONAL SUPPLY CORPORATION
30 ROCKEFELLER PLAZA
NEW YORK, N. Y. . . . U. S. A.

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LIMITED LIABILITY

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PLOESTI, ROUMANIA

•

MARACAIBO, VENEZUELA

a = physical radius of the pipe line, in inches.

a' = "electrical radius" of the pipe line, in inches.

c = soil cover, in inches.

h = the vertical distance in inches between the center of the pipe line and the ground surface.

r = the radial geometrical variable; the radial distance in inches from the pipe center to a point in the test plane.

x = the geometrical variable; usually the lateral distance in inches from the point on the ground surface directly over the center of the pipe to another point on the surface of the ground in the test plane.

t = the thickness of the pipe coating in inches.

z = the ratio of h to a.

α = the portion of drain current at the point of test.

A, B, C, K, k = constants.

(2) *Electrical quantities*

I = the drain current in amp.

i = the galvanic current in milliamp. leaving the pipe per cm. of length at the point of test.

i' = the total current in milliamp. leaving the pipe per cm. of length at the point of test.

$i_\square$, $i_\square'$ = the current density in milliamp. per sq. ft. of pipe surface.

$\Delta i_\square$ = the current density due solely to an external source: $\Delta i = i' - i$.

R_c, C_c = the resistance in ohms per sq. ft., and conductance in mhos per sq. ft., respectively, of the pipe coating.

ρ = the resistivity of the soil, in ohm-centimeters.

V_r, V_x, V_h, V_t, V_a = the galvanic potential readings in millivolts (mv.) of the pipe with reference to an electrode respectively positioned as follows: in general, at r; on the ground surface, at x; at a particular point, h; on the coating surface, and at the pipe or coating surface on the vertical and outside the "polarization film."

V'_r, V'_x, V'_h, V'_t, V'_a = the similar potential readings when an external soil current source is operative.

$\Delta V'_{r''r'}$ = the difference in potential between electrodes positioned in general at points r'' and r', either galvanic or due to an external current i' respectively. Examples: ΔV_{xh}, ΔV_{ht}, ΔV_{ha}, ΔV_{ta}, ΔV_{xa}, $\Delta V_{xa'}$, etc., representing in order, potential diffeffrences between x and h; h and t; h and a; t and a; x and a, and x and a'.

$\Delta_i V_r$ = the change in potential of an electrode at r caused by the interruption of the current i'. Examples: $\Delta_i V_x$, $\Delta_i V_h$, $\Delta_i V_t$, $\Delta_i V_a$.

$\Delta^2_i V_{r''r'}$ = the change in difference in potential between electrodes at the points r'' and r', caused by the interruption of the current i'. Examples: $\Delta^2_i V_{hx}$, $\Delta^2_i V_{ht}$, $\Delta^2_i V_{ha}$, $\Delta^2_i V_{ta}$.

Important Definitions and Relationships

(1) *Primary definitions*

$h = c + a + t$ (or usually $c + a$)

$z = h/a$

$\Delta i = i' - i$

$\alpha = i/1000\,I = \Delta i/1000\,\Delta I$

(2) *The basic equation and its derivatives*

$$V_r = V_a + \frac{i\rho}{2\pi} \ln r/a \quad . \quad . \quad . \quad (3)$$

$$\frac{dV}{d\ln r} = \frac{i\rho}{2\pi} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$\frac{dV}{di} = \frac{\rho \ln r}{2\pi} + \frac{dV_a}{di} \quad . \quad . \quad . \quad . \quad (5)$$

$$\frac{d^2V}{di\,d\ln r} = \frac{\rho}{2\pi} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

(3) *Equations applicable to a buried pipe line and derived from equation* (3)

$$V_x = V_a + 0.0063\,ai_\square\,\rho \log \frac{(b^2 - x^2)}{a(2b - a)}$$

where x is measured downward on the vertical . . . (8) (modified)

$$V_x = V_a + 0.0063\,ai_\square\,\rho \log \frac{(b^2 + x^2)}{a(2b - a)}$$

where x is measured along the ground surface . . . . (9) (modified)

$$V_h = V_a + 0.0063\,ai_\square\,\rho \log \frac{b^2}{a(2b - a)}, \text{ when } x = 0$$

$R_c \Delta V_{ta} = k\rho \Delta V_{ta'}$ (definition of the electrical radius.)

$$\frac{a'}{a} = z \pm \sqrt{z^2 - \frac{(2z - 1)}{\log^{-1}(159\,R_c/\rho a)}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

$$a' = h - \sqrt{h^2 - 10^B} \quad . \quad . \quad . \quad (28)$$

Equations (8) and (9) are made applicable to coated pipe lines (or to pipe lines that behave as though coated) by the substitution of $a'(2h - a')$ for $a(2h - a)$. Similar equations are applicable in V'_x and V'_h when $i'_\square$ is substituted for $i_\square$.

(4) *Equations derived from equation* (4)

$$\Delta V_{xh} = 0.0063\,ai_\square\,\rho \log \frac{h^2 + h^2}{h^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

$$\Delta V_{ha} = 0.0063\,ai_\square\,\rho \log \frac{h^2}{a(2h - a)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

$$\Delta V_{xa} = 0.0063\,ai_\square\,\rho \log \frac{h^2 + x^2}{a(2h - a)}$$

(x on ground surface)

$$\Delta V_{xa} = 0.0063\,ai_\square\,\rho \log \frac{h^2 - x^2}{a(2h - a)}$$

(x on vertical)

$$\Delta V_{ta} = \Delta V_{aa} = 0.0063 ai_\square\,\rho \log \frac{a(2h - a)}{a'(2h - a')}$$

where t is negligible with respect to a. . . . . (33)

Similar equations are applicable in $\Delta V'_{xh}$, etc., when $i'_\square$ is substituted for $i_\square$.

(5) *Equations derived from equation* (5)

$$\Delta_i V_x = 0.0063\,a\Delta i_\square\,\rho \log \frac{h^2 + x^2}{a(2h - a)} + \Delta V_a \quad . \quad . \quad . \quad . \quad (26) \text{ (modified)}$$

$$\Delta_i V_h = 0.0063\,a\Delta i_\square\,\rho \log \frac{h^2}{a(2h - a)} + \Delta V_a, \text{ when } x = 0$$

If the pipe line is coated or behaves as though coated, $a'(2h - a')$ is substituted for $a(2h - a)$.

(6) *Equations derived from equation* (6)

Equations in the form $\Delta^2_i V_{xh}$ are each respectively equal to the equations in section (4) (above) when $\Delta i_\square$ is substituted for $i_\square$. For example,

$$\Delta^2_i V_{xh} = 0.0063\,a\Delta i_\square\,\rho \log \frac{h^2 + x^2}{h^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

(7) *Current density equations*

(a) When the multiplier A is elected:

$$i_\square = \frac{A\Delta V_{xh}}{\rho}, \text{ when } x = yh. \quad (17)$$

and $\Delta i_\square = \dfrac{A\Delta^2_i V_{xh}}{\rho}$, when $x = yh$, and:

$$y = \sqrt{\log^{-1}\frac{159}{Aa} - 1} \quad . \quad . \quad . \quad (18)$$

(b) When, by convention, $\Delta V_{xh} = \Delta V_{ht}$ and $\Delta^2_i V_{xh} = \Delta^2_i V_{ht}$, then:

$$i_\square = \frac{K\Delta V_{xh}}{\rho} \quad . \quad . \quad . \quad . \quad . \quad (22)$$

$$\Delta i_\square = \frac{K\Delta^2_i V_{xh}}{\rho} \quad . \quad . \quad . \quad . \quad . \quad (32)$$

provided:

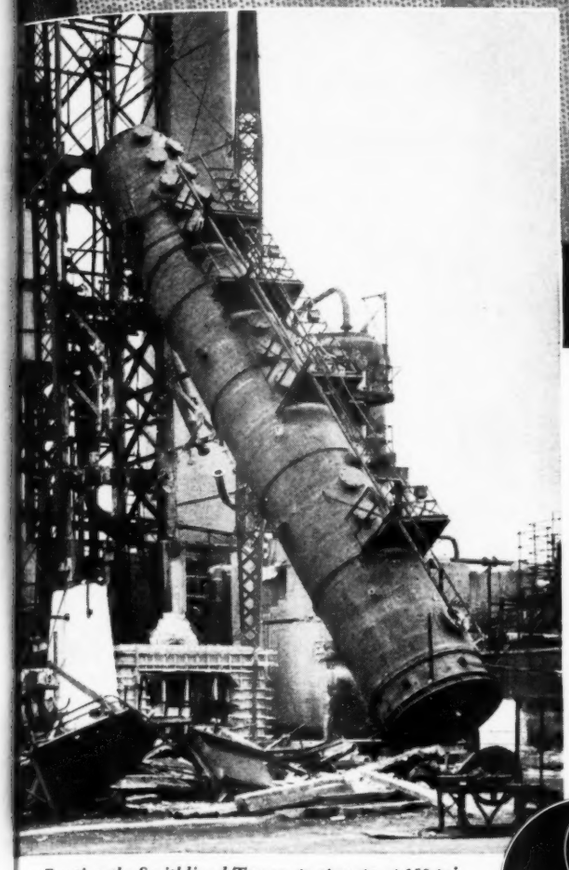
$$\frac{x}{a} = \frac{z(z - 1)}{\sqrt{2z - 1}} \quad . \quad . \quad . \quad . \quad . \quad (24)$$

and $Ka = 1/0.0063 \log \dfrac{z^2}{(2z - 1)}$ . . . . . (25)

(8) *Illustrative increment relationships*

$\Delta^2_i V_{xh} = \Delta V'_{xh} - \Delta V_{xh} =$
$(V'_x - V'_h) - (V_x - V_h)$
$= (V'_x - V_x) - (V'_h - V_h)$
$= \Delta_i V_x - \Delta_i V_h$

Another Major Refiner Specifies SMITHLINING



Erecting the Smithlined Tower, to operate at 150 psi. and 750° F. in a major midwestern refinery.

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Second, that vessel size is no obstacle to Smith. No matter how huge or complicated your vessels must be, Smith facilities are equal to the task.

To benefit fully from Smith's vast metallurgical experience, bring your vessel problems to Smith when you *begin* to plan refinery expansion or modernization. A. O. Smith Corporation, Milwaukee, Wisconsin. Offices at New York, Pittsburgh, Chicago, Tulsa, Dallas, Shreveport, Houston, Corpus Christi, Los Angeles, Seattle.

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Multicolumn Fractionation in the Natural Gasoline Industry

PART 2

by F. D. Parker, Research Supervisor, Union Oil Company of California

THE data and Fig. 3A (see Part 1) are not to be taken as rigorous and should not be used for design purposes. The reflux ratio, plate requirement, etc., should be checked for the individual separation under consideration by one or several of the methods reported in the literature. The reflux and plate requirements vary widely with the sharpness of separation between components desired. The lines of Fig. 3A are based on 90-95 percent recovery of the lighter key component in the overhead and a similar recovery of the heavy key component in the bottoms. If the recovery quota can be relaxed, a considerable reduction in reflux can be tolerated. For example, in the separation of *iso*pentane from normal pentane, the recovery of 50 percent of the *iso*pentane with less than 10 percent normal pentane contamination can be accomplished in a 24-plate tower with a reflux ratio of about 6:1. This is well below the reflux rate at which a number of *iso*butane towers operate despite their easier separation, because of the requirements for maximum *iso*butane recovery in the latter case.

Along this line, it might be noted that 85 percent recovery of 95 percent *iso*butane can be made with a reflux ratio of 5:1; 94 percent recovery with a reflux ratio of 7:1, and 98 percent with a reflux ratio of 10:1. These are typical figures for columns containing 45, 50, and 65 plates.

A further factor affecting separation between components such as *iso*butane and normal butane is the presence of lighter and heavier components. The separation between *iso*butane and normal butane is made more difficult (i.e., requires more reflux or plates) when propane and lighter is present and/or when pentane and heavier is present. This is because some of the trays, especially in the vicinity of the feed tray, are utilized for separation of the non-key components. (See Fig. 4.)

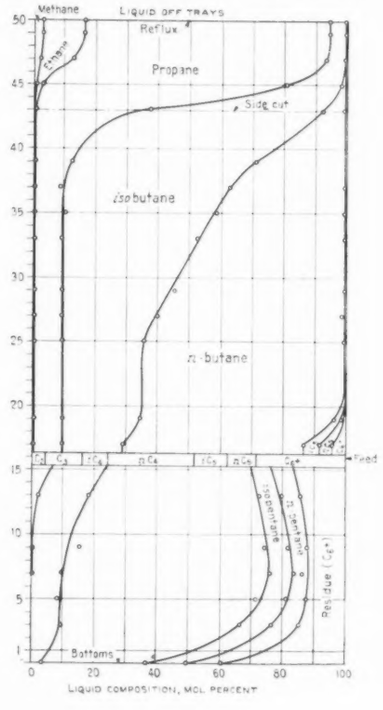
Liquid Gas Production

Liquid petroleum gas or L.P.G. is a common commodity to producers and refiners of natural gasoline. It appears in two general forms or products: (1) commercial propane, and (2) commercial butane. The California Natural Gasoline Association recognizes[5] six grades of liquid gas designated as A, B, C, D, E, and F, ranging in vapor pressure from 80 lb. per sq. in. gauge at 100°F. (fundamentally butane) to 200 lb. per sq. in. gauge at 100°F. (predominantly propane). The production of these commodities requires the ability to fractionate between propane and butane on the one hand and butane and pentane on the other.

A photograph and biographical sketch of the writer can be found on page 130 of the Annual Number (July 1) of The Petroleum Engineer, *in connection with Part 1 of this article.*

[5] C.N.G.A., *Liquefied Petroleum Gas Standards*, 1939.

Fig. 4. Tray liquid composition in mol percent with respect to tray position



1. Production of liquid petroleum gases from a single tower. Fig. 5 is a diagrammatic representation of fractionator facilities for the production of both liquid propane and liquid butane from a single tower. In addition to the overhead and bottoms production streams shown in Figs. 2 and 3, a third product stream is drawn from the column at a point in the rectifying section approximately midway between the top plate and the feed plate.

In the general discussion of fractionation it was noted that liquid on trays in the rectifying section of the tower is lightest at the top and becomes heavier toward the feed tray due to the "absorbing-out" action on the heavy key component. There is some point in the tower above the feed tray where a liquid "side cut" stream can be drawn at a rate less than the overhead rate without the side cut, and this stream will be rich in butane and deficient in propane. At the proper rate of side cut withdrawal, with adequate top reflux and with the side cut point properly located, the side cut stream can be made to consist of all the butane that would normally appear overhead plus some of the propane. The overhead thus consists only of propane and lighter. In practice this point of withdrawal is determined by temperature gradient in the rectifying section of the tower, and the material is withdrawn to a point whose temperature corresponds, as determined by calculation and experience, to the desired composition. For a given feed composition, column operating pressure, and vapor pressure of stable product being produced from the bottom, the lower the temperature of the side cut stream, the larger the percent of propane; conversely, the higher the temperature of the side cut stream, the larger the percent of butane in the cut.

Fig. 4 shows the actual concentration gradient for the components methane, ethane, *iso*butane, and normal butane and heavier through a stabilizer

that was producing a commercial butane side cut, and Fig. 6 is the tower temperature gradient. These data have appeared in several publications.[6] Fig. 6 plus the preceding discussion illustrate why it is impossible to produce a pure component as a side cut from a fractionating column. All the material lighter than the desired side cut component must pass by the side cut tray on the way from the feed plate to the top of the tower and because of equilibrium or tendency toward equilibrium on each plate in the rectifying section of the tower there will be at least a small concentration of material lighter than that desired dissolved in the liquid side cut stream.

The advantages of single tower operation for the production of liquid petroleum gases principally concern the equipment:

1. Only one tower need be installed, so equipment cost is low.

2. Existing towers primarily for straight stabilization of natural gasoline can be quite readily modified to include means for withdrawal of liquid from trays in the rectifying section, thus producing liquid propane and liquid butane products.

The disadvantages are:

1. Control—As noted the composition of the withdrawn side cut is a function of the composition of the feed and is roughly determined during operation by the temperature of the side cut tray. Constant attention is required during operation as the temperature (and therefore the composition) of the material on the side cut trays varies quite widely with a relatively small variation in the composition of the feed to the stabilizer.

2. Operation—The withdrawal of a butane side cut containing a portion of the propane that would otherwise appear in the overhead means that the overhead reflux is deficient in heavy materials that aid in condensation. Therefore relatively minor upsets in the cooling system by which reflux is provided may result in inability to obtain a low enough temperature to produce a condensate for reflux and column control is lost.

3. Loss of product—Referring to item 2 above, the same exceedingly volatile characteristics of the overhead material that make it difficult to produce reflux at all times due to inability to effect condensation also involves the loss of gas of propane that might otherwise be recovered as a liquid and sold.

[6]Brown, G. G., Souders, Mott, Jr., Nyland, H. V., and Hesler, William W., *Ind. and Eng. Chem.*, 27, April, 1935.

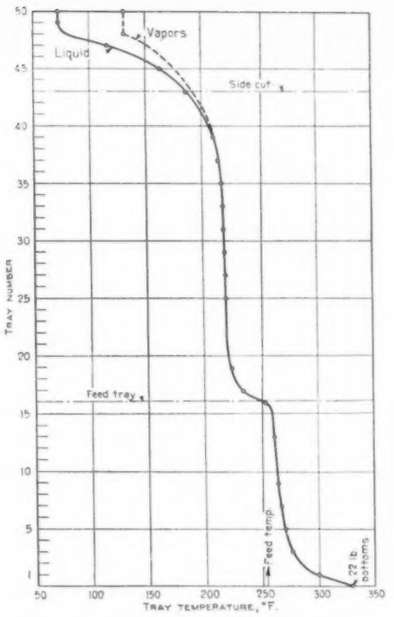
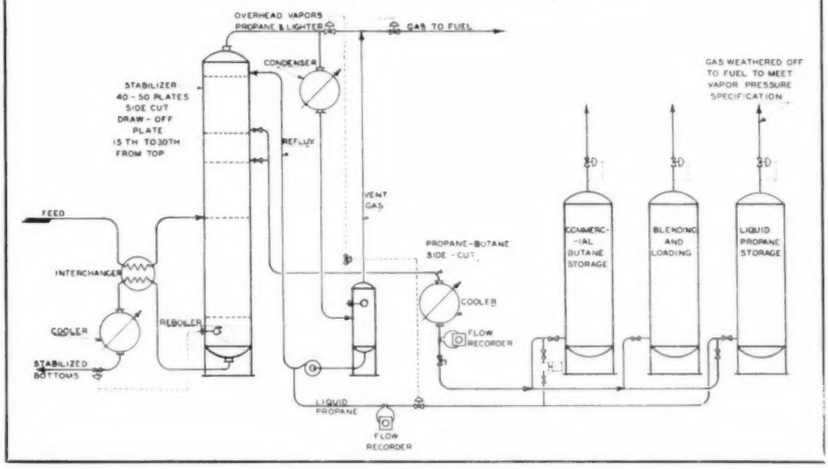


Fig. 6. Tray temperature gradients at 285 lb. gauge pressure

2. Production of liquid petroleum gas products from two columns. To reduce the difficulties of control and operation and a loss of potential propane products noted as characteristic of single column procedure for the production of liquid petroleum gas, liquid propane and liquid butane can be made by the use of two columns operating in series.

Fig. 7 shows diagrammatically a typical installation to effect the separation of propane and butane from natural gasoline. Raw feed from the wild gasoline accumulator is fed to the first of the towers in series, from which is produced overhead virtually all the propane, methane, and ethane present in the feed. Depending upon the composition of the feed and hence the difficulty of effecting condensation for reflux overhead, the tower will operate at a pressure ranging from 200-300 lb. per sq. in. As propane is almost completely produced overhead and is present in the bottom stream in only a small quantity, the overhead material is easier to condense than in the single column when a considerable quantity of the propane is being removed with the butane in a side cut from the rectifying section. This aids both in control of the column by minimizing the possibility of loss of reflux due to upsets in the cooling system, and also effects a greater percentage of condensation of the propane that is then available after weathering or other treatment to meet commercial vapor pressure specifications. Control is also simplified in that such close attention to bottom temperature is not required as with the case of side cut temperature in the production of butane as a side cut from the rectifying section of the single column setup. Principal attention is required to avoid contamination of the overhead with butane, whereas the presence of a reasonably small amount of propane in the bottoms is not deleterious inasmuch as propane is generally blended back with the overhead butane product from the second tower to meet vapor pressure specifications. The bottoms from this primary tower (consisting of a trace of propane, virtually all the *iso*butane, all the normal butane, and all the heavier components present in the feed) are pressured to the secondary column, and the rate of transfer is controlled by a liquid-level controller on the bottom of the primary tower. The secondary tower, which is essentially a debutanizer, can operate at a considerably lower pressure than the primary depropanizing tower or for that matter a normal stabilizer. Customary pressures for this tower range from 40 to 60 lb. per sq. in. gauge. Operation at 100-200 lb. is not uncommon, however. The bottoms pressure is adjusted to that value which

Fig. 5. Illustrating an arrangement whereby both liquid propane and liquid butane may be produced from a single tower



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Permaset wire lines have greater flexibility to withstand high speed action over many sheaves. It has added strength to take heavy impact loads and uniformity of construction to stand up under drum-crushing. Made of J&L Controlled Quality Steel — by men of skill and experience — J&L Permaset is *pre-formed* for long, hard service — extra service per dollar. Specify J&L Permaset when you order rotary drilling lines, tubing lines, sucker-rod lines and winch lines from your nearest supply store.

J&L STEEL

JONES & LAUGHLIN STEEL CORPORATION

AMERICAN IRON AND STEEL WORKS • PITTSBURGH, PENNSYLVANIA

J&L — PARTNER IN PROGRESS TO AMERICAN INDUSTRY

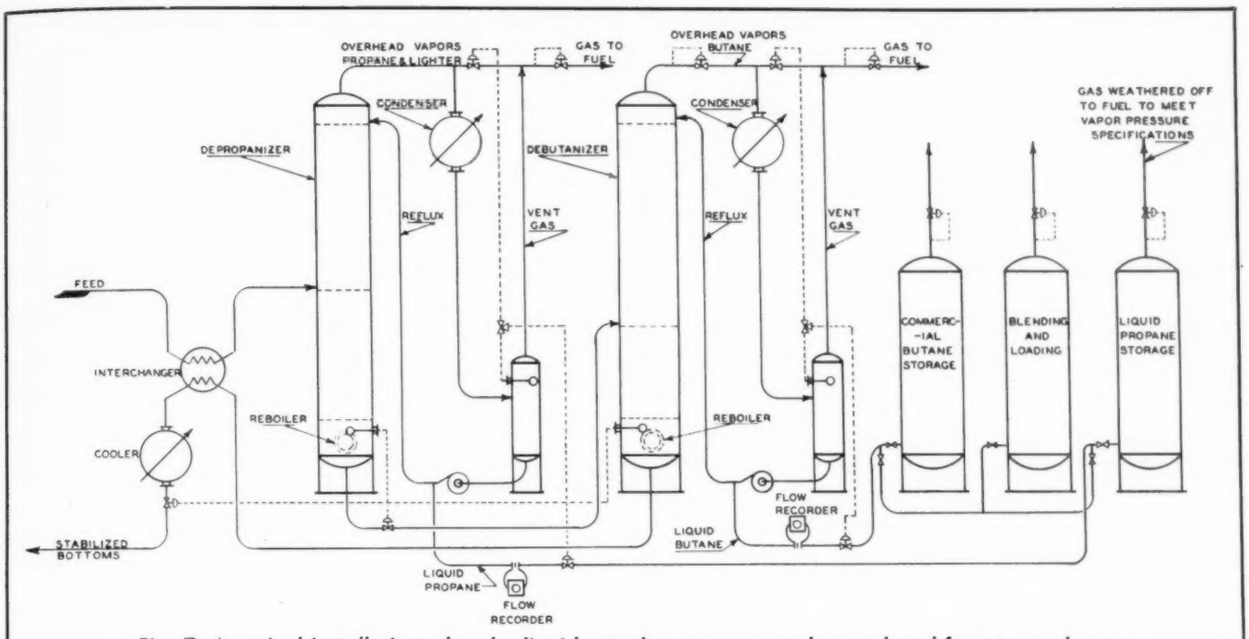


Fig. 7. A typical installation whereby liquid petroleum gases may be produced from two columns

will produce the desired vapor pressure material in a manner similar to normal stabilizer operations, and the overhead consisting predominantly of butane (*iso-* and normal), is condensed, a portion is returned for reflux, and the net overhead is produced to storage.

The advantages of the double column installation discussed are:

1. Easier control for the production of commercial butane.

2. Less possibility of loss or reflux due to condensation difficulties.

3. Greater propane recovery for potential sale.

The disadvantages are:

1. The installation investment is approximately twice as much as the corresponding single tower installation. This is true even though one or the other towers may be considerably smaller than the single tower installation above, because in a large measure the cost of the installation is determined not by the weight of the vessel itself, but by the required amount of piping, foundation work, instrumentation, etc.

2. Although reflux difficulties are considerably reduced as compared with the single column installation, the light fractions, methane and ethane, are still present in the overhead and may present difficulties on occasion.

3. As a corollary to 2, fractional condensation of the overhead results in a loss to gas of propane, which in certain instances might be salable as liquid gas if recovered. To effect condensation and recovery, column pressures are generally rather high with the result that the condensate as produced contains an excessive amount of dissolved methane and ethane that must be removed before the product will meet vapor pressure specifications. This is generally done by a weathering operation in the storage tank, whereby the pressure on the tank is gradually reduced from stabilizer pressure down to that corresponding to the specifications for the material after correcting the pressure to the specification pressure of 100°F. This weathering operation results in an appreciable loss of propane to gas, no matter how carefully conducted. The more slowly this weathering is conducted, the greater the staging effect and the less loss of propane to gas. Shipment schedules and so forth generally make it difficult to weather the liquid as slowly as desired with the result that a considerable loss of propane to gas occurs.

3. Production of liquid petroleum gas products from three columns. In a discussion of the production of liquid petroleum gas products from two columns, it was noted that difficulties of condensation and propane product recovery are encountered in the primary column due principally to the presence of dissolved methane and ethane. This is particularly significant in plants employing high-pressure absorption because the concentration of methane and ethane in the wild gasoline is considerably higher than in the case of low-pressure absorption plants. The following data illustrate analyses of typical wild gasoline feeds to stabilizers from absorption plants operating at about 60-lb. pressure and 475-lb. pressure, respectively:

	Analysis of wild gasoline, liquid volume percent	
Component	*60-lb. absorption*	*475-lb. absorption*
Methane, CH_4	0.2	0.9
Ethane, C_2H_6	0.8	8.9
Propane, C_3H_8	8.0	34.7
*Iso*butane, i-C_4H_{10}	6.3	7.9
Normal butane, n-C_4H_{10}	22.8	21.8
*Iso*pentane, i-C_5H_{12}	4.0	9.9
Normal Pentane, n-C_5H_{12}	4.0	4.8
Residue, C_6+	53.9	11.1
Total	100.0	100.0

These figures show that, based on equal volumes of propane, the high-pressure wild gasoline has a methane concentration equal to the low-pressure gasoline, and an ethane concentration 2.6 times as high. It follows, therefore, that the overhead from the primary stabilizer column consisting of propane and lighter will be condensed with more difficulty in the case of the gasoline containing the larger percentage of methane and ethane. To offset this difficulty a third column often called a de-ethanizer is sometimes used. Fig. 8 diagrammatically shows the installation of such a column in conjunction with a depropanizer and a debutanizer set-up for the production of liquid petroleum gas products. In this case wild gasoline feed from the accumulator tanks is pumped to the primary tower, which in this case is a de-ethanizer and which operates at a pressure of 500 to 600 lb. per sq. in. The overhead from this tower consists of ethane, methane, and a trace of propane. The bottoms containing only a trace of ethane and most of the propane from the feed and all the *iso*butane, normal butane, *iso*-pentane, normal pentane, and heavier

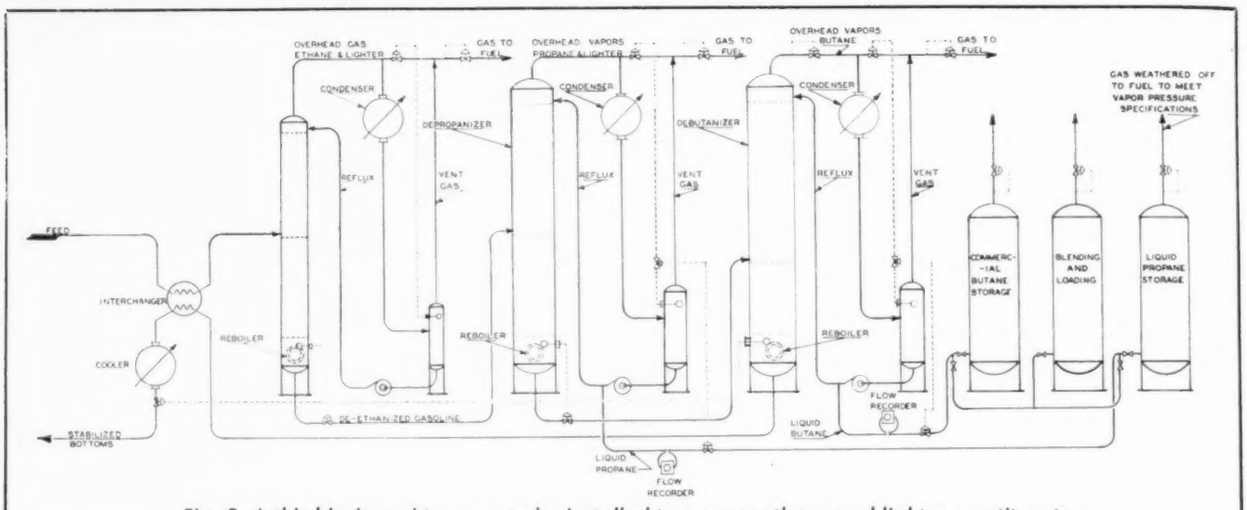


Fig. 8. A third (primary) tower may be installed to remove ethane and lighter constituents

fractions are transferred under control of a liquid-level controller at the bottom of the tower to the secondary tower, which is now the depropanizer. In the latter tower propane of considerable purity can be produced overhead and reflux production is readily obtained at pressures not exceeding 200 lb. per sq. in. From the bottom of the depropanizer, substantially propane-free material is again pressured under control of a liquid-level controller to the debutanizer tower where the gasoline is stabilized to the final desired vapor pressure and the butane overhead is withdrawn as a liquid for sale as such or for blending to make commercial liquid petroleum gas.

It should be noted that it is not necessary to de-ethanize all the wild natural gasoline. For example, the stream containing the greater portion of the ethane can be subjected to the de-ethanizer treatment and the concentration of ethane in the composite feed to the depropanizer will be correspondingly reduced. In most high-pressure absorption plants, the principal offender of all intermediate liquid products with respect to ethane concentration is the high-pressure compressor condensate. Instead of producing this material directly to the wild gasoline accumulator as is the customary procedure, this stream can be diverted through a high-pressure de-ethanizing tower, and then pressured to the wild gasoline accumulator. Stabilization of the wild gasoline for the production of propane and butane is then obtained as shown in Fig. 7, and operation is identical except that difficulties with reflux formation and propane production at the depropanizer are considerably reduced.

Stage Stabilization

In the introduction it was noted that there is a growing demand for *iso*butane and *iso*pentane, respectively, as reactants in the production of, and blending stock for, aviation gasoline.

The production of these commodities, together with liquid gas products, presents a problem in stage fractionation of natural gasoline.

There are three basic ways in which the desired fractions can be produced by fractional distillation:

1. By stage stabilization, i.e., taking off successively lighter cuts in a series of stabilizers. The cuts made are propane and lighter, *iso*butane, normal butane, and *iso*pentane. (See Fig. 9A.)

2. *Iso*butane-normal butane fractionation in the wild gasoline followed by depropanizing of the *iso*butane and debutanizing and de-*iso*pentanizing of the stabilizer bottoms. Fig. 9B illustrates this method.

3. Depropanizing the wild gasoline followed by debutanizing to produce butane-free gasoline, fractionating out *iso*pentane from the latter, and separating *iso*butane from normal butane. Fig. 9C shows this method.

EDITOR'S NOTE: This article will be continued in an early issue.

Alternative arrangements of fractional distillation equipment, differing principally in the relative position of the deisobutanizer

Fig. 9A

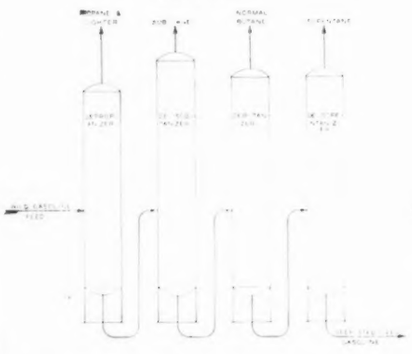


Fig. 9B

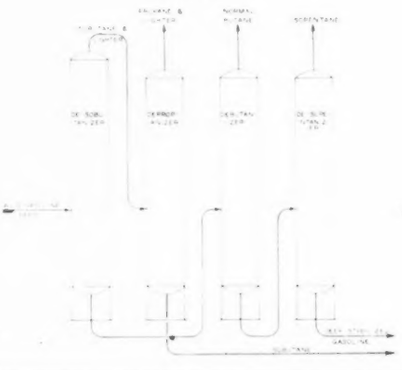
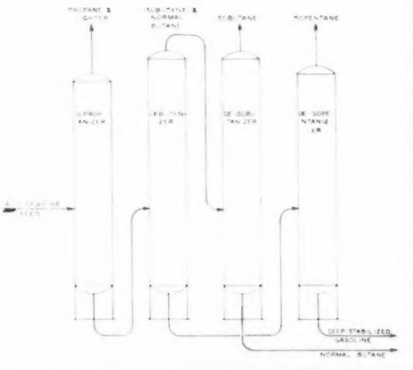


Fig. 9C



THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT No. 49

The present installment of the Continuous Tables marks the beginning of the fifth year since this valuable contribution was adopted as a regular feature of *The Petroleum Engineer*. Singularly steadfast adherence to the objective of presenting readily understood tables that would assist plant and field engineers and operators in the solution of their day to day problems has stimulated the interest of thousands of our readers in diligently filing and using the Tables.

The 48 installments of the Tables published thus far have comprised 294 tables, distributed among general fields of interest as follows:

	No. of Tables
General	38
Drilling	93
Production	63
Pipe Line	56
Refining and Natural Gasoline	44
	294

Thus far, all the material presented in the Tables has consisted of tabular data rather than graphs, curves, alignment charts, or the other methods of presenting relationships between two or more variables. Data presented in table form are more readily followed by the average reader than those presented in graphical form. Most types of information are

best presented by curves or nomographs when three or more variables must be considered simultaneously. Data in the form of charts and graphs will later be included with the Tables. At the present time, however, it is planned to adhere to the table form in presenting the wealth of information that still remains unavailable in handbooks or other sources to which the average field man has access.

Many times our readers have indicated an interest in the source of so many tables. In brief, all the tables have developed largely as a result of suggestions from our readers themselves, many of whom are always on the lookout for practical information reduced by computation to tabular form readily applicable in obtaining the answer to a problem that might otherwise require a more or less tedious calculation.

Many suggestions have been made for tables that pertain to machinery design and similar problems. Although such tables might be of value to those engaged in design work, they would be of little interest to the greater number of readers working in plants and in the field not required to engage in designing. Likewise, designers usually have adequate reference sources at hand and have calculating machines available so that their need of the Tables is less urgent.

For the benefit of those readers who are only now becoming interested in the Continuous Tables, it should be pointed out that all tables are assigned a filing or index number that conforms with the Dewey Decimal System of classification as modified and extended for the petroleum industry by L. C. Uren, professor of Petroleum Engineering at the University of California.

In earlier installments of the Tables, the complete index was published and is now available at a cost of 50 cents per copy from *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas.

INDEX TO TABLES*

Title of Table	*Index No.*	*Page*	*Issue*
Rise in fluid level, etc., due to running 1½-in. non-upset tubing in well fluid	P 511.141.150.2	91	July
Velocity of flow, ft. per sec., through annulus between 1½-in. and 4-in. tubing (sheet 3B)	P 533.300.150.2	89	July
Gravity of dry oil in oil-water mixtures, deg. A.P.I.	P 677.410.301	87	July

*This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue, and 37-48, inclusive, in the June, 1941, issue.

Note: Attention is called to the fact that the entries in the last column on table P 511.141.125 in the May, 1941, issue and on tables P 511.141.150.1 and P 511.141.200.1 in the June, 1941, issue are incorrect. The correct values are 10 times those shown; for example, 1 ft. 7 in. or 19 in. should be 190 in. or 15 ft. 10 in.

INDEX TO ADVERTISERS IN TABLES

	Page	*Issue*	*Backing Table No.*
Bantam Bearings Corp.	88	July	P 677.410.301
Bethlehem Steel Company (sheet 3B)	90	July	P 533.300.150.2
Hyatt Bearings Division, General Motor Sales Corp.	92	July	P 511.141.150.2

GRAVITY OF DRY OIL IN OIL-WATER MIXTURES, DEG. A.P.I.

Gravity of "wet" oil deg. A.P.I.	Percent water in mixture														
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
30.0	34.5	34.8	35.2	35.5	35.9	36.3	36.7	37.1	37.5	**38.0**	38.5	38.9	39.5	39.9	40.4
.1	.7	.9	.3	.6	**36.0**	.5	.9	.2	.7	.2	.7	**39.0**	.7	**40.0**	.6
.2	.8	**35.0**	.4	.8	.2	.6	**37.0**	.4	.8	.4	.8	.2	.8	.2	.8
.3	.9	.1	.6	.9	.3	.7	.1	.5	**38.0**	.5	.9	.3	.9	.4	**41.0**
.4	**35.0**	.2	.7	**36.0**	.4	.8	.2	.6	.1	.6	**39.0**	.5	**40.0**	.6	.1
30.5	35.1	35.4	35.8	36.2	36.6	**37.0**	37.4	37.8	38.3	38.7	39.2	39.7	40.2	40.7	41.2
.6	.3	.6	**36.0**	.4	.7	.2	.5	.9	.4	.8	.3	.8	.3	.9	.4
.7	.4	.7	.1	.5	.8	.3	.7	**38.0**	.6	**39.0**	.4	**40.0**	.4	**41.0**	.5
.8	.5	.8	.2	.6	**37.0**	.4	.8	.2	.7	.1	.6	.1	.6	.2	.6
.9	.6	**36.0**	.4	.8	.1	.5	**38.0**	.3	.8	.3	.7	.2	.8	.3	.8
31.0	35.7	36.1	36.5	36.9	37.3	37.7	38.1	**39.0**	39.4	39.9	39.9	40.4	40.9	41.5	**42.0**
.1	.9	.3	.7	**37.0**	.4	.9	.2	.7	.2	.6	**40.0**	.6	**41.0**	.7	.2
.2	**36.0**	.4	.8	.2	.5	**38.0**	.4	.8	.3	.7	.2	.8	.2	.8	.4
.3	.1	.5	.9	.3	.7	.1	.5	.9	.4	.9	.3	**41.0**	.4	**42.0**	.6
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37.5	36.4	36.7	37.1	37.5	37.9	38.4	38.8	39.2	39.7	40.2	40.7	41.2	41.7	42.3	42.9
.6	.6	.8	.2	.6	**38.0**	.6	.9	.4	.8	.3	.8	.4	.9	.4	**43.0**
.7	.7	**37.0**	.3	.8	.2	.7	**39.0**	.6	**40.0**	.5	**41.0**	.6	**42.0**	.6	.2
.8	.8	.1	.5	**38.0**	.3	.8	.2	.7	.2	.6	.2	.7	.2	.7	.3
.9	.9	.2	.6	.1	.4	**39.0**	.3	.8	.4	.7	.4	.8	.3	.9	.5
32.0	**37.0**	37.4	37.8	38.2	38.6	39.1	39.5	**40.0**	40.5	40.9	41.5	**42.0**	42.5	43.1	43.7
.1	.2	.6	.9	.4	.7	.3	.7	.2	.6	**41.0**	.7	.2	.7	.3	.9
.2	.3	.7	**38.0**	.5	.9	.4	.8	.3	.8	.2	.8	.3	.8	.4	**44.0**
.3	.4	.8	.1	.6	**39.0**	.5	.9	.4	.9	.3	.9	.4	**43.0**	.6	.2
.4	.5	.9	.3	.7	.1	.6	**40.0**	.5	**41.0**	.5	**42.0**	.5	.1	.8	.3
32.5	37.6	**38.0**	38.4	38.9	39.3	39.7	40.2	40.7	41.2	41.7	42.2	42.7	53.3	43.9	44.5
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33.0	38.3	38.7	39.1	39.5	**40.0**	40.4	40.9	41.4	41.9	42.4	**43.0**	43.5	44.1	44.7	45.3
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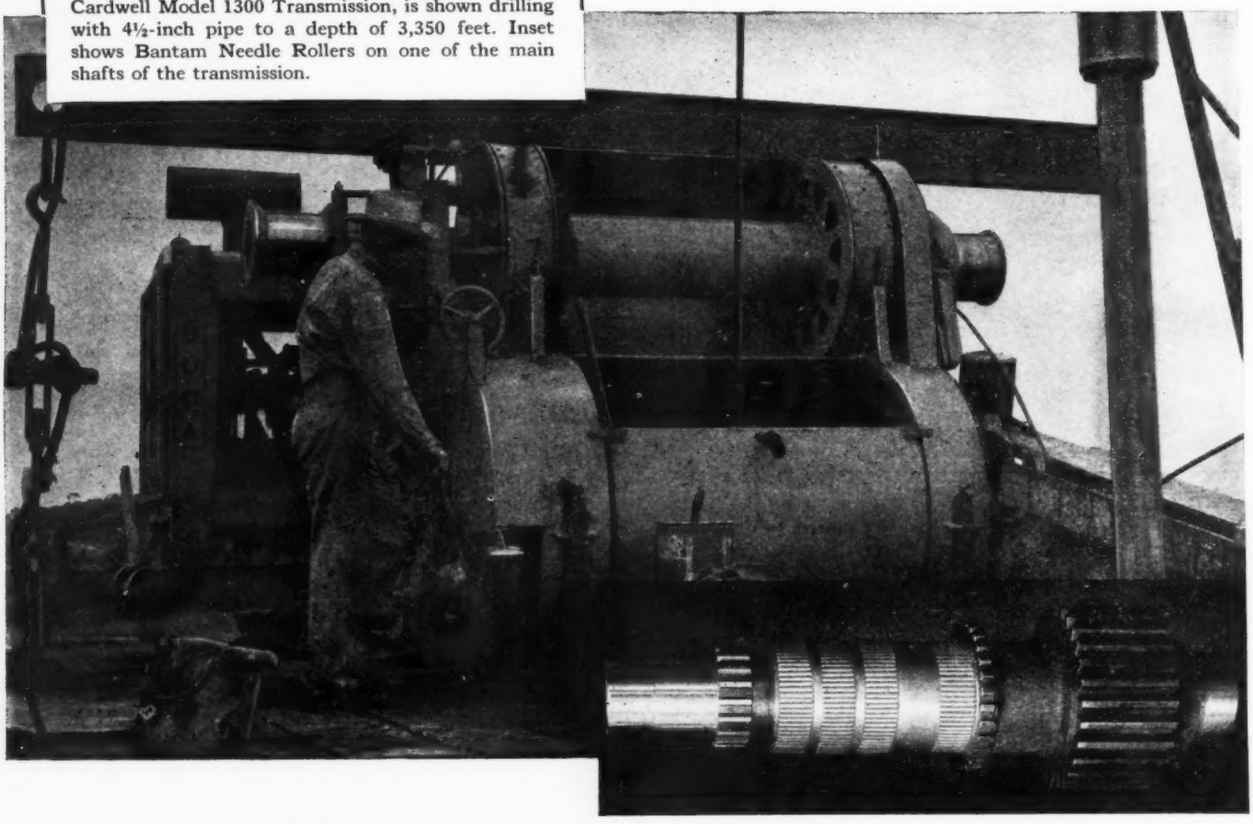
.2	.6	**39.0**	.3	.8	.3	.6	.2	.7	.1	.7	.3	.8	.5	**45.0**	.6
.3	.7	.1	.5	**40.0**	.4	.8	.3	.9	.3	.9	.4	**44.0**	.6	.2	.8
.4	.8	.2	.6	.1	.5	**41.0**	.4	**42.0**	.5	**43.0**	.5	.1	.8	.4	**46.0**
33.5	38.9	39.3	39.7	40.2	40.6	41.1	41.6	42.1	42.6	43.2	43.7	44.3	44.9	45.5	46.1
.6	**39.0**	.5	.8	.4	.8	.2	.8	.2	.8	.3	.8	.5	**45.0**	.7	.2
.7	.2	.6	**40.0**	.5	.9	.3	.9	.4	**43.0**	.5	**44.0**	.6	.2	.9	.4
.8	.3	.7	.2	.6	**41.0**	.4	**42.0**	.5	.1	.6	.2	.8	.4	**46.0**	.6
.9	.4	.9	.3	.7	.1	.6	.1	.7	.2	.8	.3	**45.0**	.6	.1	.8
34.0	39.5	**41.0**	40.4	40.9	41.3	41.8	42.3	42.8	43.4	43.9	44.5	45.1	45.7	46.3	**47.0**
.1	.7	.2	.6	**41.0**	.5	**42.0**	.5	**43.0**	.5	**44.0**	.7	.3	.9	.5	.2
.2	.8	.3	.7	.2	.6	.1	.6	.1	.7	.2	.9	.5	**46.0**	.7	.4
.3	.9	.4	.8	.3	.7	.2	.7	.3	.9	.4	**45.0**	.7	.2	.9	.5
.4	**40.0**	.5	.9	.4	.8	.4	.8	.5	**44.0**	.6	.1	.8	.4	**47.0**	.6
34.5	40.2	40.6	41.1	41.5	**42.0**	42.5	**43.0**	43.6	44.1	44.7	45.3	45.9	46.5	47.1	47.8
.6	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.6	.5	.5	.5
.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	.7	. 7	.7	.7
.8	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
.9	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8

This Model R double drum draw works, equipped with Cardwell Model 1300 Transmission, is shown drilling with 4½-inch pipe to a depth of 3,350 feet. Inset shows Bantam Needle Rollers on one of the main shafts of the transmission.



AIDING CARDWELL PERFORMANCE

Bantam Bearings contribute to successful operation of heavy-duty transmissions

Progressive design and efficient operation of Cardwell equipment are outstanding reasons for the company's success during its 15 years of service to the oil industry. Typical example of Cardwell design is the Model 1300 Transmission—a five-speed, even-ratio transmission built installation with heavy-duty prime movers, constructed throughout to withstand severe service.

Contributing factor in the efficient performance of the Model 1300 Transmission is the use of Bantam Needle Rollers on one of the main shafts. Providing exceptionally high load-carrying capacity in proportion to bearing size, these Needle Rollers offer the advantages of long bearing life and economical, power-saving operation. Cardwell has installed 41 of these transmissions in various types of rigs since October, 1939, and not a single case of bearing failure has occurred!

Performance of these bearings is typical of the ways in which Bantam Bearings and Bantam engineering are serving the makers and users of oil well equipment. Angular Contact Bearings for rotaries—Quill Bearings for saddles and pitmans on pumpers—Journal Roller Bearings for blocks and swivels—these are some of the other Bantam Bearings widely used by progressive equipment manufacturers. For bearings that will give high capacity, long life, efficient operation, *TURN TO BANTAM.*

BANTAM BEARINGS CORPORATION, South Bend, Indiana

BANTAM BEARINGS

STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

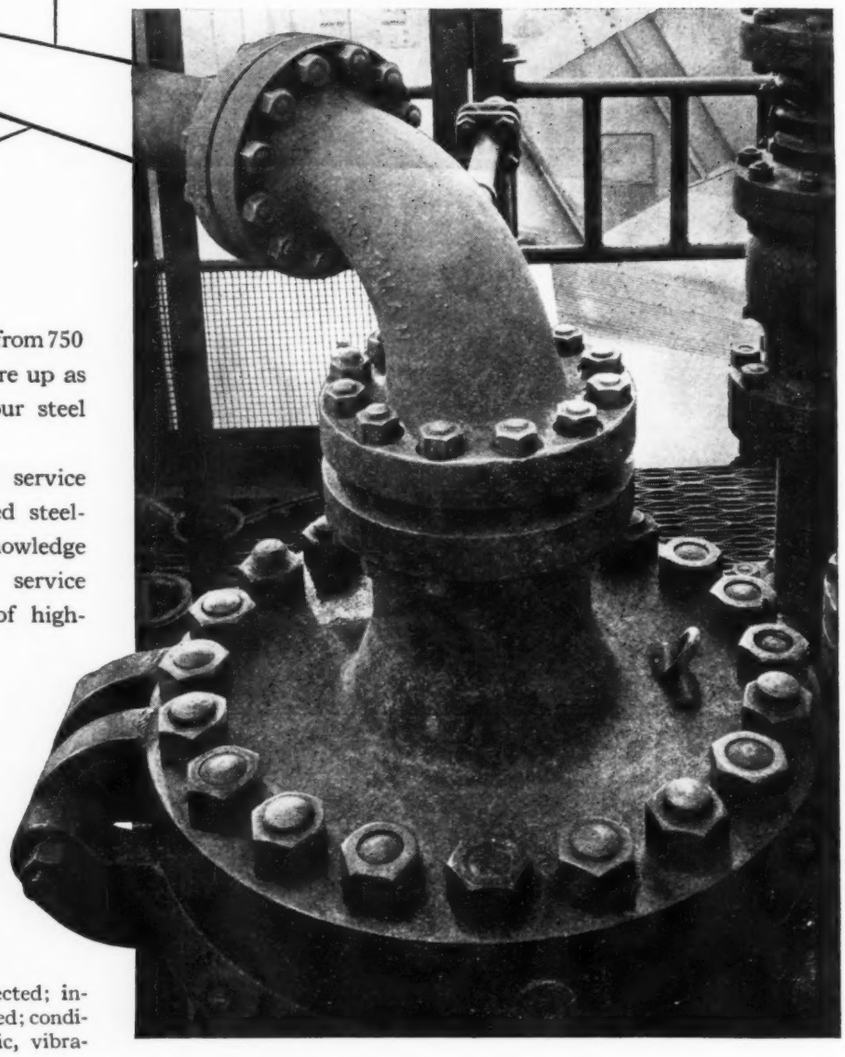
VELOCITY[1] OF FLOW, FT. PER SEC., THROUGH ANNULUS BETWEEN 1½-IN. AND 4-IN. TUBING

Rate of production, bbl. per day	Gas-oil ratio, cu. ft. per bbl.	Tubing pressure[2] at casinghead, lb. per sq. in. gauge								
		0	25	50	75	100	125	150	175	200
50	1000	9.0	3.3	2.1	1.5	1.2	1.0	0.8	0.8	0.7
100		18.0	6.7	4.2	3.0	2.4	2.0	1.7	1.6	1.3
150		27.4	10.0	6.2	4.5	3.6	3.0	2.5	2.4	2.0
200		36.1	13.4	8.3	6.1	4.8	4.0	3.4	3.2	2.7
250		45.1	16.7	10.4	7.6	6.0	5.0	4.2	4.0	3.3
300		54.1	20.1	12.5	9.1	7.2	6.0	5.1	4.8	4.0
350		63.1	23.4	14.6	10.6	8.4	6.9	5.9	5.6	4.6
400		72.1	26.8	16.6	12.1	9.6	7.9	6.8	6.4	5.3
50	1250	11.0	4.2	2.8	1.9	1.5	1.2	1.0	1.0	0.8
100		22.1	8.3	5.6	3.8	3.0	2.5	2.1	2.0	1.6
150		33.1	12.5	8.5	5.6	4.5	3.7	3.1	3.0	2.5
200		44.2	16.7	11.3	7.5	5.9	4.9	4.2	4.0	3.3
250		55.2	20.9	14.1	9.4	7.4	6.1	5.2	5.0	4.1
300		66.3	25.0	16.9	11.3	8.9	7.4	6.3	6.0	4.9
350		77.3	29.2	19.8	13.2	10.4	8.6	7.3	6.9	5.7
400		88.4	33.4	22.6	15.1	11.9	9.8	8.4	7.9	6.5
50	1500	13.3	5.0	3.1	2.2	1.8	1.5	1.2	1.1	1.0
100		26.7	10.0	6.2	4.5	3.5	2.9	2.5	2.2	1.9
150		40.0	15.0	9.3	6.7	5.3	4.4	3.7	3.3	2.9
200		53.3	20.0	12.4	9.0	7.1	5.9	5.0	4.4	3.9
250		66.6	25.0	15.5	11.2	8.9	7.3	6.2	5.5	4.8
300		80.0	30.0	18.6	13.5	10.6	8.8	7.5	6.6	5.8
350		93.3	35.0	21.7	15.7	12.4	10.3	8.7	7.7	6.8
400		106.6	40.0	24.8	18.0	14.2	11.7	10.0	8.7	7.8
50	1750	15.5	5.8	3.6	2.6	2.1	1.7	1.5	1.4	1.1
100		30.9	11.7	7.2	5.2	4.1	3.4	2.9	2.7	2.2
150		46.4	17.5	10.8	7.8	6.2	5.1	4.4	4.1	3.4
200		61.8	23.3	14.4	10.5	8.2	6.8	5.8	5.5	4.5
250		77.3	29.1	18.0	13.1	10.3	8.5	7.3	6.8	5.6
300		92.7	35.0	21.6	15.7	12.4	10.2	8.7	8.2	6.7
350		108.2	40.8	25.2	18.3	14.4	11.9	10.2	9.6	7.9
400		123.6	46.6	28.8	20.9	16.5	13.6	11.6	11.0	9.0
50	2000	17.7	6.6	4.1	3.0	2.3	1.9	1.6	1.5	1.3
100		35.3	13.3	8.2	6.0	4.7	3.9	3.3	2.9	2.6
150		53.0	19.9	12.3	8.9	7.0	5.8	4.9	4.4	3.8
200		70.6	26.6	16.4	11.9	9.4	7.7	6.6	5.9	5.1
250		88.3	33.2	20.6	14.9	11.7	9.7	8.2	7.4	6.4
300		105.9	39.9	24.7	17.9	14.1	11.6	9.9	8.8	7.7
350		123.6	46.5	28.8	20.9	16.4	13.6	11.5	10.3	8.9
400		141.2	53.2	32.9	23.9	18.8	15.5	13.2	11.8	10.2
50	2250	19.9	7.5	4.6	3.3	2.6	2.2	1.8	1.7	1.4
100		39.7	15.0	9.2	6.7	5.3	4.3	3.7	3.5	2.9
150		59.6	22.4	13.9	10.0	7.9	6.5	5.5	5.2	4.3
200		79.4	29.9	18.5	13.4	10.5	8.7	7.4	7.0	5.7
250		99.3	37.4	23.1	16.7	13.2	10.9	9.2	8.7	7.2
300		119.1	44.9	27.7	20.1	15.8	13.0	11.1	10.5	8.6
350		139.0	52.3	32.3	23.3	18.4	15.2	12.9	12.2	10.2
400		158.8	59.8	37.0	26.8	21.1	17.4	14.8	14.0	11.4
50	2500	22.1	8.3	5.1	3.7	2.9	2.4	2.0	1.9	1.6
100		44.1	16.6	10.3	7.4	5.8	4.8	4.1	3.9	3.2
150		66.1	24.9	15.4	11.1	8.8	7.2	6.1	5.8	4.8
200		88.2	33.2	20.5	14.9	11.7	9.6	8.2	7.7	6.3
250		110.3	41.5	25.6	18.6	14.6	12.0	10.2	9.7	7.9
300		132.3	49.8	30.8	22.3	17.5	14.4	12.3	11.6	9.5
350		154.4	58.1	35.9	26.0	20.4	16.8	14.3	13.5	11.1
400		176.4	66.4	41.0	29.7	23.4	19.2	16.4	15.5	12.7

[1]Solution of gas and condensation under pressure are not considered; hence the values are maxima.
[2]Gas volumes entering into velocity calculations are based on tubinghead pressure; atmospheric pressure is assumed to be 15 lb. per sq. in. in calculating the number of atmospheres.

BETHLEHEM STEELS...

for structural stability at service temperatures



WHEN service temperatures range from 750 deg. to 1050 deg. F., and pressures are up as well, then structural stability in your steel fastenings is important.

Structural stability in steels at service temperatures depends on coordinated steel-making experience, metallurgical knowledge and first-hand information about service conditions. To get the most out of high-temperature fastenings, you must:

Consider Stresses—maximum expected; initial stresses and how applied and controlled; conditions of loading, whether static, dynamic, vibratory, or repeated.

Figure Corrosion—study the atmospheres and corrosive media encountered.

Anticipate Temperatures—what the maximum will be, and what average can be expected.

Study the Characteristics of Steel—strength and ductility at normal and elevated temperatures; corrosion and scaling resistance; and structural stability at the service temperature.

Utilize Bethlehem's Experience—Bethlehem pioneered in the development of a number of the more popular steels for high-temperature service. During the past 15 years extensive laboratory tests have been carried on, with recent large additions to the testing equipment. And wide experience with the use of steels for high-temperature service under varying conditions forms an ideal background for recommendations. With a record of more than 50 years of making fine alloy steels for all industry, Bethlehem is excellently equipped to aid in the selection of the steel best suited to the particular service requirements. We will be glad to confer with you in respect to the most economical solution of your question involving high temperature fittings.

New Catalog Available—We have recently published a catalog giving information about Bethlehem steels available for high-temperature service. A copy will be sent on request.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY

RISE IN FLUID LEVEL, ETC., DUE TO RUNNING 1½-IN. NON-UPSET TUBING IN WELL FLUID

Diameter of outer string or open hole, in.	Internal diameter of outer string or open hole, in.	Volume[1] contained in outer string or open hole		Volume[1] contained in annular space		Volume[1] in well bore when tubing is in hole (volume in annulus plus volume in tubing)		For every 100 ft. of tubing run in fluid, fluid level will be raised:	
		gal.	bbl.	gal.	bbl.	gal.	bbl.	in annular space when lower end of tubing is closed, ft.-in.	in well bore when lower end of tubing is open, ft.-in.
Tubing strings									
Non-upset									
2½	2.441	24.31	0.579	9.50	0.226	20.08	0.478	155–11	20–10
3	2.992	36.52	.870	21.71	0.517	32.29	.769	68– 3	13– 0
3	2.922	34.84	.829	20.03	0.477	30.61	.729	73–11	13– 8
3½	3.548	51.36	1.223	36.55	0.870	47.13	1.122	40– 6	11– 5
4	3.958	63.92	1.522	49.11	1.169	59.69	1.421	30– 2	7– 0
Upset									
2½	2.441	24.31	0.579	9.50	0.226	20.08	0.478	155–11	20–10
3	2.992	36.52	.870	21.71	0.517	32.29	.769	68– 3	13– 0
3½	3.476	49.30	1.174	34.49	0.821	45.07	1.073	42–11	9– 3
4	3.958	63.92	1.522	49.11	1.169	59.69	1.421	30– 2	7– 0
Casing strings[2]									
4½	4.090	68.25	1.625	53.44	1.272	64.02	1.524	27– 9	7–10
4½	3.920	62.69	1.493	47.88	1.140	58.46	1.392	30–11	8– 7
5	4.560	84.84	2.020	70.03	1.667	80.61	1.919	21– 2	5– 2
5	4.276	74.60	1.776	59.79	1.424	70.37	1.675	24– 9	7– 2
5½	5.044	103.8	2.471	88.99	2.119	99.57	2.371	16– 8	5– 1
5½	4.670	88.98	2.119	74.17	1.766	84.75	2.018	20– 0	5–11
6	5.524	124.5	2.964	109.7	2.612	120.3	2.864	13– 6	3– 6
6	5.240	112.0	2.667	97.2	2.314	107.8	2.567	15– 3	3–11
6⅝	6.135	153.6	3.657	138.8	3.305	149.4	3.557	10– 8	2–10
6⅝	5.675	131.4	3.129	116.6	2.776	127.2	3.029	12– 8	3– 4
7	6.538	174.4	4.152	159.6	3.800	170.2	4.052	9– 3	2– 6
7	5.920	143.0	3.405	128.2	3.052	138.8	3.305	11– 7	3– 0
7⅝	7.125	207.1	4.931	192.3	4.579	202.9	4.831	7– 8	2– 1
7⅝	6.625	179.1	4.624	164.3	3.912	174.9	4.164	9– 0	2– 5
8⅝	8.097	267.5	6.369	252.7	6.017	263.3	6.269	5–10	1– 7
8⅝	7.511	230.2	5.481	215.4	5.129	226.0	5.381	6–11	1–10
9⅝	9.063	335.1	7.979	320.3	7.626	330.9	7.879	4– 7	1– 3
9⅝	8.535	297.2	7.076	282.4	6.724	293.0	6.976	5– 3	1– 5
10¾	10.192	423.8	10.090	409.0	9.738	419.6	9.990	3– 7	1– 0
10¾	9.760	388.7	9.255	373.9	8.902	384.5	9.155	4– 0	1– 1
11¾	11.150	507.2	12.076	492.4	11.724	503.0	11.976	3– 0	0–10
11¾	10.772	473.4	11.271	458.6	10.919	469.2	11.171	3– 3	0–11
13⅜	12.715	659.6	15.705	644.8	15.352	655.4	15.605	2– 4	0– 9
13⅜	12.347	622.0	14.810	607.2	14.457	617.8	14.710	2– 5	0–10
Open hole (bit size)[3]									
2⅞	2.875	33.73	0.803	18.92	0.450	29.50	0.702	78– 6	14– 2
3⅞	3.875	61.27	1.459	46.46	1.106	57.04	1.358	31–11	7– 4
4¼	4.250	73.70	1.755	58.89	1.402	69.47	1.654	25– 2	7– 3
4¾	4.750	92.06	2.192	77.25	1.839	87.83	2.091	19– 2	4– 9
5⅝	5.625	131.4	3.129	116.6	2.776	127.2	3.029	12– 8	3– 4
6	6.000	146.9	3.498	132.1	3.145	142.7	3.398	11– 3	2–11
6⅛	6.125	153.1	3.645	138.3	3.293	148.9	3.545	10– 9	2– 8
6½	6.500	172.4	4.105	157.6	3.752	168.2	4.005	9– 5	2– 6
6¾	6.750	185.9	4.426	171.1	4.074	181.7	4.326	8– 8	2– 4
7	7.000	199.9	4.760	185.1	4.407	195.7	4.660	8– 0	2– 2
7½[4]	7.500	229.5	5.464	214.7	5.112	225.3	5.364	6–11	1–10
7¾[4]	7.750	245.1	5.836	230.3	5.483	240.9	5.736	6– 5	1– 9
8½[4]	8.500	294.8	7.019	280.0	6.667	290.6	6.919	5– 3	1– 5
9¾[4]	9.750	387.9	9.236	373.1	8.883	383.7	9.136	4– 0	1– 1
10⅝	10.625	460.6	10.967	445.8	10.614	456.4	10.867	3– 4	0–11

The 1½-in. non-upset tubing has a calculated weight of 2.74 lb. per ft. (including a coupling spaced every 20 ft.). The volume displaced by 100 ft. of tubing and 5 couplings: (1) by the steel itself (with lower end of tubing open), 4.187 gal. or 0.0997 bbl.; (2) by the pipe (with lower end of tubing closed), 14.81 gal. or 0.3525 bbl. The volume contained within 100 ft. of the tubing is 10.575 gal. or 0.2518 bbl.

[1]All volume figures are based on 100 ft. of depth; multiply to convert to other depths or lengths. For example, if the depth or length is 5196 ft., multiply by 51.96.

[2]Only maximum and minimum weights of pipe are shown for each casing size.

[3]Variation in diameter of open hole due to caving, etc., is disregarded.

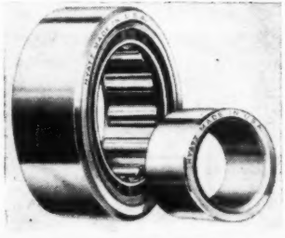
[4]This diameter is an average of the two bit sizes ⅛ in. larger and smaller, respectively.

Table suggested by George B. Rice, Butler & Horne Drilling Co., Dallas, Texas.

KEEP THEM YOUNG WITH HYATTS

LUFKIN PUMPING UNITS, like their Hyatt equipment, stand foremost in design and performance throughout the petroleum industry.

ALL THE WAY THROUGH—from our exacting steel specifications, positive controlled heat treating, exclusive precision grinding methods, unrelenting process and finished product inspections—quality is built into Hyatt Roller Bearings to make them perform so well and so long. Are you enjoying the advantages of Hyatt Quality in the equipment you build or buy? Tell us when and where we can serve you. Hyatt Bearings Division, General Motors Sales Corporation, Harrison, N. J.; Chicago, Pittsburgh, Detroit and San Francisco.



HYATT

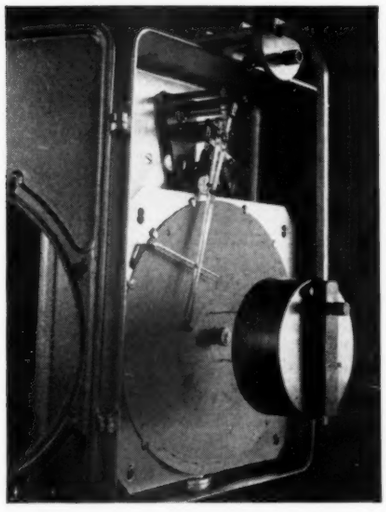
ROLLER BEARINGS

QUIET

California "Gadget" Contest Brings Forth Many Valuable Ideas

☆ Practical utility of the many entries emphasizes ingenuity and thought given to jobs by workmen in the industry

INDIVIDUALS concerned with the manufacture of natural gasoline, the transportation of gas into plants, and the handling of products are continually developing devices to improve operation and increase safety. Realizing the value of such devices, or "gadgets," the California Natural Gasoline Association arranged a joint meeting of the Los Angeles and Taft chapters at Lebec, California, and there offered an opportunity for the inventors of the equipment to present the various devices to the industry. Prizes were awarded on the basis of originality and ingenuity, value to the industry, adaptability and practicability, simplicity, and convenience of construction. All the devices have been in practical service but none has yet been manufactured commercially. There were 75 entries. Drawings or photographs of the entries with descriptions of construction and operation are now on file at the headquarters of the California Natural Gasoline Association, 510 West 6th Street, Los Angeles, California. Complete details of any of the devices listed may be procured from the Association.



Auxiliary Front Drive Clock. This device may be clamped on the front of any meter to run a one-hour chart without making it necessary to reset the static and differential pens, change clock, etc. The photograph shows the auxiliary attachments in use and indicates its operation

The following entries were made:

"A Piston Puller for Vertical Engines," entered by Kenneth D. Eastman, General Petroleum Corporation.

"Gas Engine Fuel Economizer," entered by E. D. Smyser, C. C. M. O. Company.

"Volatile Liquid Pump Discharge Surge Chamber," entered by Warren Kraft, Honolulu Oil Corporation.

"Dropped Ring Preventer," entered by Clarence A. Davis, The Texas Company.

"Method of Changing Wedge Bolts in Clark Engines," entered by Clarence A. Davis, The Texas Company.

"A Reliable Pilot to Keep Fires Burning and to Prevent Fire Box Explosions," entered by J. H. Boyle.

"Flywheel Safety Lock for Cooper Engines," entered by T. C. Wallace, Southern Counties Gas Company.

"Handles for Acetylene Containers," entered by R. N. Gingles, Standard Oil Company of California.

"Stopcock Changers," entered by Jay R. Brick, Southern California Gas Company.

"Tube Cutter for Griscom-Russell Condenser Sections," entered by J. P. Ioppini, Belridge Oil Company.

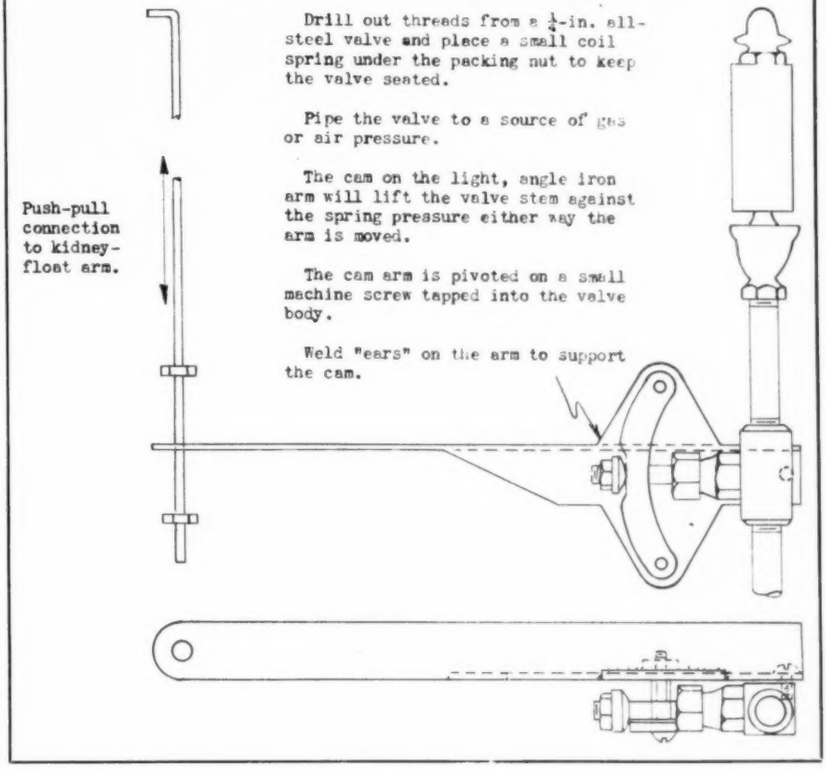
"Cylinder Crack Sealer," entered by A. Kittelberger, Signal Oil and Gas Company. Gadget first made by Clarence Baker, deceased.

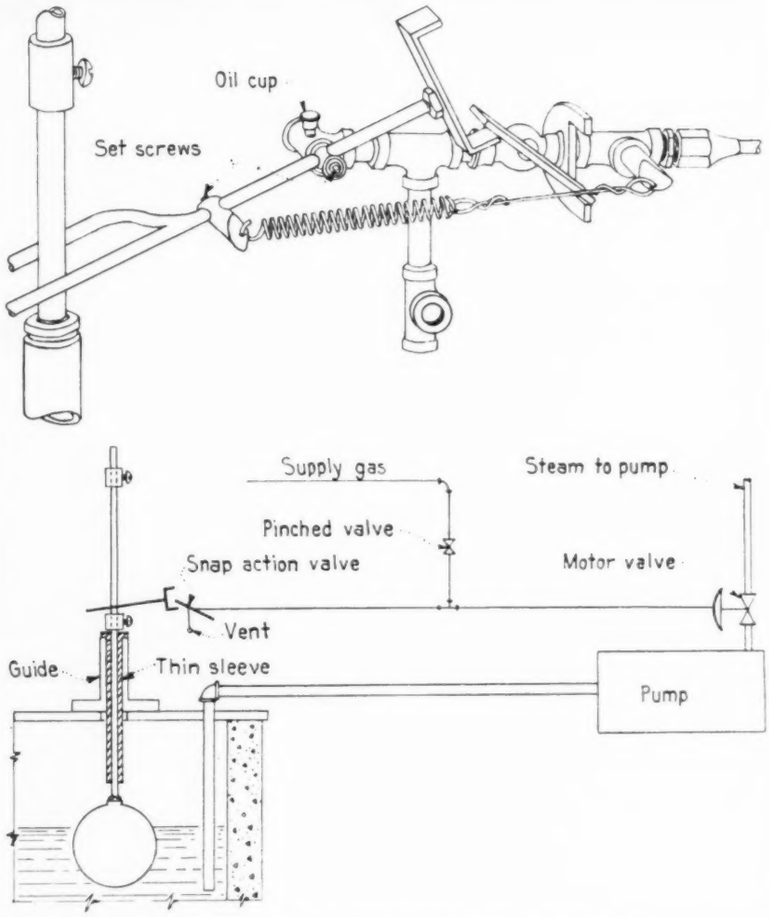
"Special Slide Rule for Gravity Calculation," entered by W. T. Switzler, Standard Oil Company of California.

"Back Bearing Remover for Westcott Gauge," entered by H. Jimenez of the Southern California Gas Company.

"Main Shaft Aligner," entered by Ed Ruppert, Southern California Gas Company.

High and Low Liquid Level Alarm. This device is used to cause a warning whistle to blow automatically when liquid level becomes dangerously high or low. The construction is shown by the drawing


Drill out threads from a ¼-in. all-steel valve and place a small coil spring under the packing nut to keep the valve seated.
Pipe the valve to a source of gas or air pressure.
The cam on the light, angle iron arm will lift the valve stem against the spring pressure either way the arm is moved.
The cam arm is pivoted on a small machine screw tapped into the valve body.
Weld "ears" on the arm to support the cam.
Push-pull connection to kidney-float arm.



Snap Action Valve. This device is designed for the control of a sump pump. The details are indicated in the drawing. The upper part of the drawing shows the snap action valve hooked-up. The lower part illustrates the control system for intermittent operation of a sump pump

Automatic Drip Unloader or Trap. This equipment is used to drain condensate from gas lines or scrubbers and is designed to work on either vacuum or pressure. The float is powerful enough to operate with water, gasoline, crude oil, or foaming basic sediment

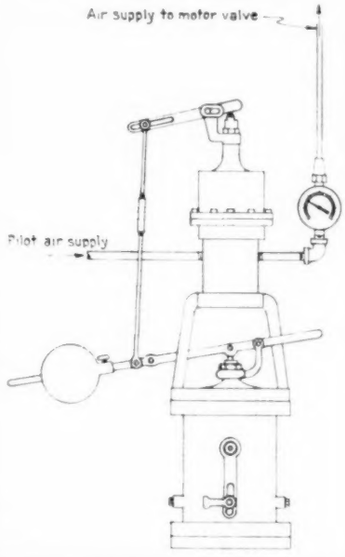
"Core Loosener," entered by C. C. Beard, C. C. M. O. Company.

"Combination Dope and Soap Can," entered by Jay R. Brick, Southern California Gas Company.

"Ring Expander," entered by Earl I. Levings, Lomita Gasoline Company.

"Procedure for Testing Leaky Condenser Tubes with Air," entered by Bennett Schock, General Petroleum Corporation.

Pilot Valve Steam Pump Speed Governor. This is an adaptation of a steam pump speed governor to pilot valve for motor valve operation on steam supply line to pump. It is especially adapted to high-pressure super-heat steam supply. The details of the design are indicated by the drawing. Equipment is composed of a steam pump governor together with a suitable bracket and support coupled to an air pilot valve having necessary levers for motor valve control



"Gas Flow Direction Indicator," entered by Woodrow Krigbaum, C. C. M. O. Company.

"An Auxiliary Front Drive Clock," entered by Melroy Welck, Barnsdall Oil Company.

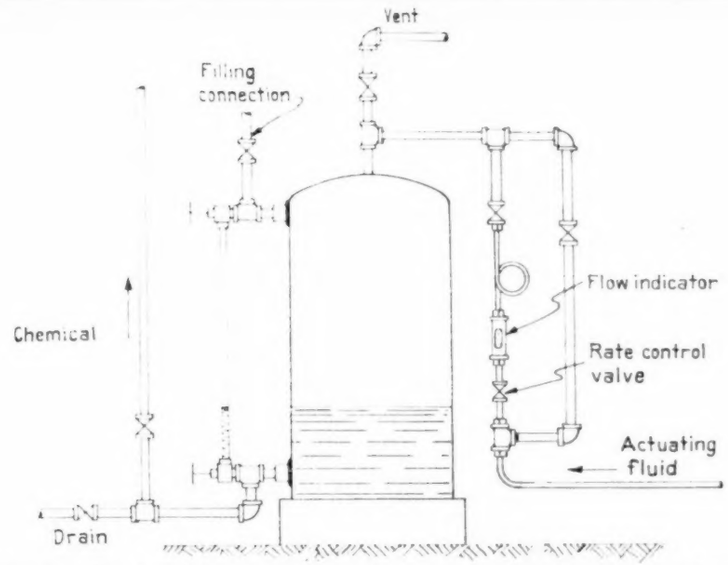
"Circulating Water Heater," entered by Jack Colvin, O. C. Field Gasoline Corporation.

"Chemical Feeder," entered by H. R. Alfson, General Petroleum Corporation.

"Valve Jack for Worthington Gas Engines," entered by Roy Lemmon, Union Oil Company.

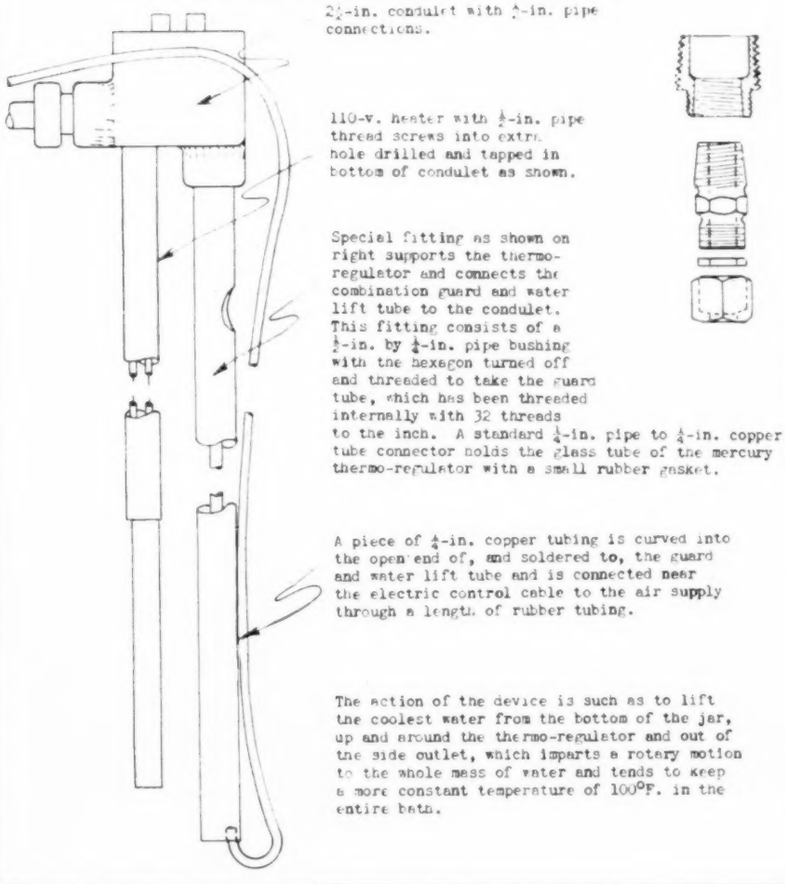
"High and Low Liquid Level Alarm," entered by J. F. Webster, O. C. Field Gasoline Corporation.

"Glycol Dispenser Made from Standard Fittings," entered by Jack Colvin, O. C. Field Gasoline Corporation.



Chemical Feeder. This equipment was designed to feed a heavy boiler compound at approximately 100 drops per min. or 2 gal. per day. Referring to the drawing, the actuating fluid is throttled at the rate control valve through the flow indicator where the flow is visible. The fluid then enters the pot and displaces chemical, which exits through the line at the left of the pot. The chemical enters the rundown line ahead of the accumulator in the absorption plant cycle. Treatment at this point protects from dissolved gases, the boilers in which the condensate is used and all plant lines and tanks as well as any shipping lines into which raw gasoline or condensate may go.

Circulating Water Heater. The purpose of this device is to keep a bath at constant temperature. The action is to lift the coolest water from the bottom of the jar up and around the thermo-regulator and out the side outlet. This imparts a rotary motion to the whole mass of water and tends to keep a more constant temperature in the entire bath.


2½-in. condulet with ¾-in. pipe connections.
110-v. heater with ½-in. pipe thread screws into extra hole drilled and tapped in bottom of condulet as shown.
Special fitting as shown on right supports the thermo-regulator and connects the combination guard and water lift tube to the condulet. This fitting consists of a ½-in. by ¾-in. pipe bushing with the hexagon turned off and threaded to take the guard tube, which has been threaded internally with 32 threads to the inch. A standard ¼-in. pipe to ¼-in. copper tube connector holds the glass tube of the mercury thermo-regulator with a small rubber gasket.
A piece of ¼-in. copper tubing is curved into the open end of, and soldered to, the guard and water lift tube and is connected near the electric control cable to the air supply through a length of rubber tubing.
The action of the device is such as to lift the coolest water from the bottom of the jar, up and around the thermo-regulator and out of the side outlet, which imparts a rotary motion to the whole mass of water and tends to keep a more constant temperature of 100°F. in the entire bath.

"Top Cover Plate Remover," entered by Ed Ruppert, Southern California Gas Company.

"Specific Gravity Control Assembly," entered by D. L. Teeter, Standard Oil Company of California.

"Test Gauge Holder," entered by Jay R. Brick, Southern California Gas Company.

"Device to Raise Pressure on Gas Traps," entered by Ralph Openshaw and T. T. Rissinger, Union Oil Company.

"Repulsive Liquid Level Control," entered by H. A. Kuster, Lomita Gasoline Company.

"Device for Plugging-Off Leaking Exchanger Tubes," entered by A. Kittelberger, Signal Oil and Gas Company.

"Self Centering Metallic Gasket," entered by Emil Clark Bridgers, Corpus Christi Recycling Corporation.

"Liquid Return Manometer Head," entered by Burton Hufford, Standard Oil Company of California.

"Clarifier for Gauge Glasses on Hot, Dirty Oil," entered by Warren Kraft, Honolulu Oil Corporation.

"Orifice Meter Clock Adapter," entered by Ralph Openshaw, Union Oil Company.

"Filler for Test Motor Gasoline Tank," entered by C. D. Gard, Union Oil Company.

"Gas Sampling Bottle and Gas Sampling Tube with Special Fittings," entered by W. A. McGlashen, Southern California Gas Company.

"Differential Shaft Packing Nut Remover," entered by H. Jimenez, Southern California Gas Company.

"Cooper Exhaust Valve Spring Jack," entered by T. C. Wallace, Southern Counties Gas Company.

"Cooper Intake Valve Spring Jack," entered by T. C. Wallace, Southern Counties Gas Company.

"Automatic Chart Changer," entered by J. A. Swindle, General Petroleum Corporation.

"Dowel Drilling Jig," entered by Ralph Openshaw, Union Oil Company.

"Packing Gland Wrench for Westcott Meters," entered by L. P. W. Des Brisan, Southern California Gas Company.

"Vacuum Crank Case Ventilation for a 2-XVG Compressor," entered by Roswell S. Lee, Western States Gasoline Corporation.

"Pilot Valve Steam Pump Speed Governor," entered by Clyde H. Peter, Belridge Oil Company.

"Device for Recovery of Condensed Water and Heat from Preheater Condensate," entered by Eugene Newman, Gilmore-Dabney, Inc.

(Continued on Page 98)

15 YEARS OF INCREASING VALUE

WE wish to thank our many customers for the confidence placed in us, for their assistance in advising us what the operating men need, for their tolerance in helping us to correct our mistakes and for helping our Engineering Department improve our products. We are pleased to acknowledge that without this cooperation we could never have progressed one-half as far as we have in these past fifteen years.

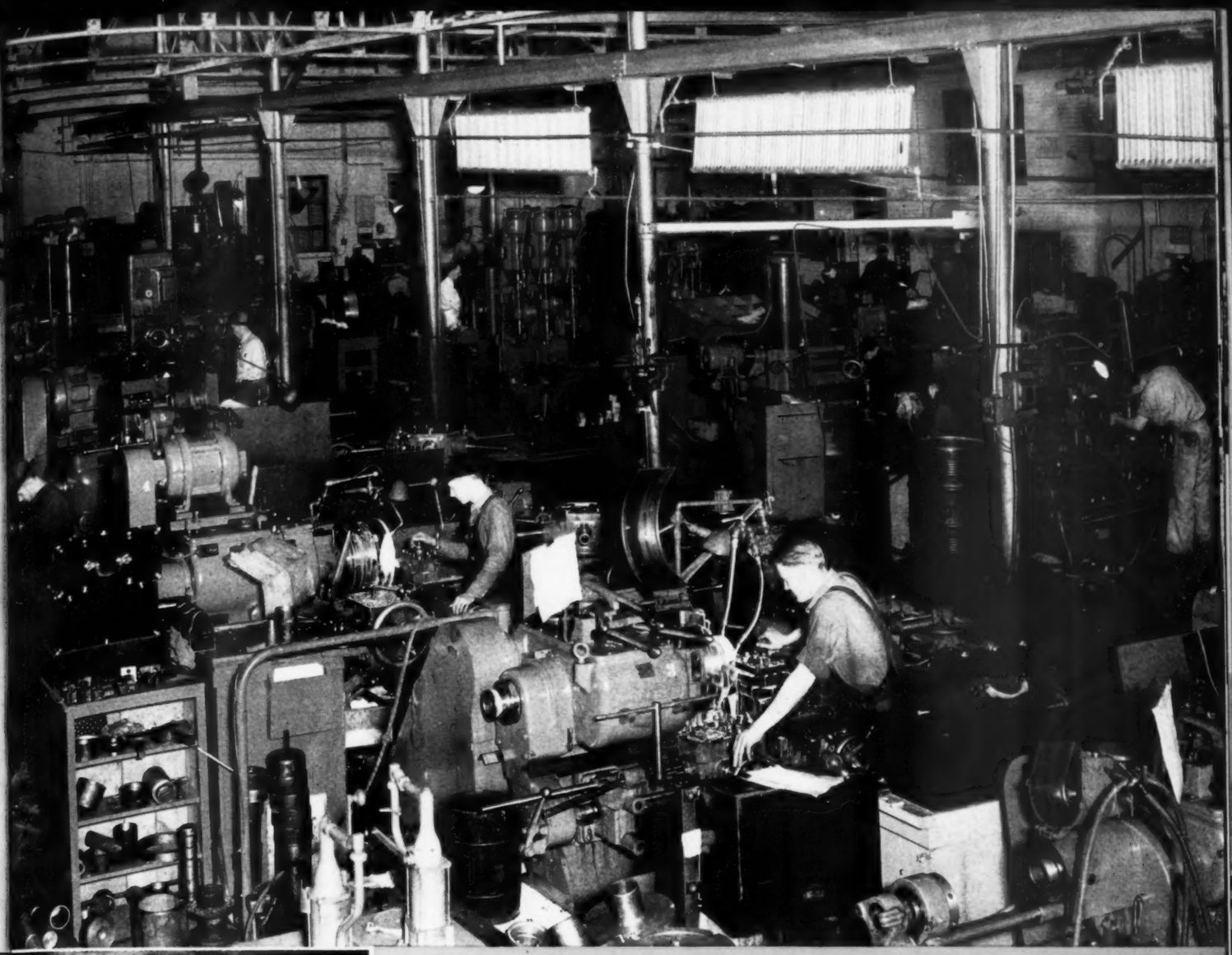
During this time we have designed, improved and placed in volume production five skid type and one pneumatic-tired servicing hoist and three sizes mounted on "Caterpillar" tractors for use on wells from 1,000 to 15,000 feet in depth; four double drum models of combination rotary and cable tool servicing and drilling rigs; four sizes of single and double drum rotary draw works, both single and twin-engine drive; and four sizes of pipe-line sidebooms and one trench backfiller for installation on "Caterpillar" tractors.

The volume of sales given us by our friends has enabled us to continually improve our products without materially advancing our prices.

Through the careful selection of personnel and the training of an engineering department along the most modern known methods, good design has been accomplished. With the use of alloy steels and the heat-treatment of parts subject to wear, our machines have rendered long, uninterrupted service to their owners. As a result, our users are our best sales representatives. May we suggest that you, as a prospect, contact any "Cardwell" owner.

Our policy has always been and will always be one of fairness to our users, yet with definite policies necessary to keep us in business so that "Cardwell" rigs will never be without service parts. Too, our own parts stock stores are strategically located so that parts will be available in the shortest possible time. We know full well that a rig that is down is a great loss to the owner, and a "black eye" for the manufacturer.

When you purchase a "Cardwell" rig, we feel it our contracted obligation to see that you receive top value.



Parts are made accurately in this fully equipped, modern machine shop. Almost one hundred skilled machinists and a quarter million dollars' worth of equipment insure rapid, efficient production

"Cardwell" equipment is engineered to fit oil field needs. "Guesswork" is eliminated, that's why "Cardwell" equipment performs better and lasts longer

EXPORT OFFICE
570 Lexington Avenue
Phone Plaza 5-9325
Cable Address "Cardsteel"
New York City, N. Y.

CARDWELL MFG. CO. INC.

FORMERLY ALLSTEEL PRODUCTS MFG. CO.
P. O. Drawer 7001 - Cable Addresses: "ALLSTEEL", WICHITA - "CARDSTEEL", NEW YORK
Wichita, Kansas, U. S. A.

(Continued from Page 95)

"Safe Door for XVG Flywheel Spotting," entered by I. W. Willard, Standard Oil Company of California.

"Reverse Acting Diaphragm Valve," entered by Herman H. Davis, Standard Oil Company of California.

"Lease or Field Production Operations Board," entered by J. H. Watson, Union Oil Company.

"Cooper Air Starting Valve Spring Jack," entered by T. C. Wallace, Southern Counties Gas Company.

"Orifice Meter Fitting and Tube Aligner," entered by Henry Keil and J. A. Gendron, Southern California Gas Company.

"Cooper Exhaust Valve Rocker Arm Jack," entered by T. C. Wallace, Southern Counties Gas Company.

"Goggle Case," entered by R. N. Gingles, Standard Oil Company of California.

"Cooper Main Bearing Cap Lifter," entered by T. C. Wallace, Southern Counties Gas Company.

"Scaling Tool," entered by T. T. Rissinger, Union Oil Company.

"Automatic Drip Unloader or Trap," entered by T. T. Rissinger, Union Oil Company.

"Pump Piston Ring," entered by I. B. Funk, Cowan Oil and Refining Company.

"Device for Automatically Operating Traps on Vacuum Lines," entered by Eugene Newman, Gilmore-Dabney, Inc.

"Orifice Plate Mandrel," entered by Harold Davis, Union Oil Company.

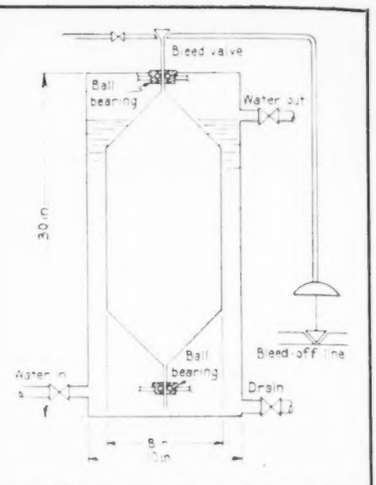
"Soft Rubber Tapered Plug to Connect Manometer to Orifice Meter," entered by C. V. Dix, Union Oil Company.

"Gauge Hand Puller," entered by Benjamin Davies, California Arabian Standard Oil Company.

"Syliphon," entered by H. A. Dresser, The Fluor Corporation, Ltd.

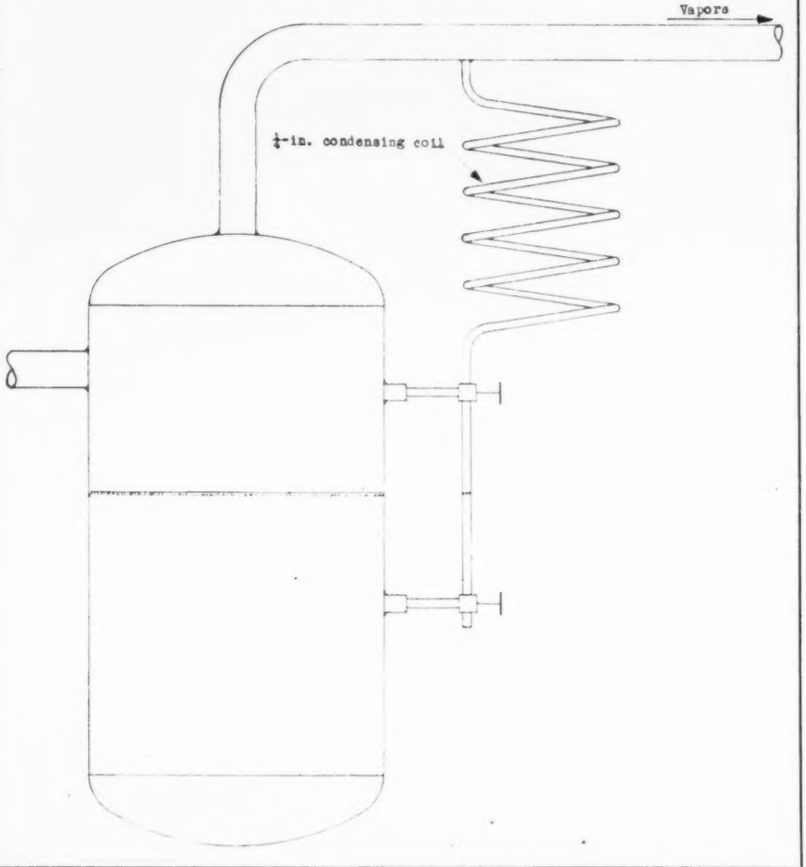
"Routine Operator," entered by D. L. Tucker, Standard Oil Company of California.

"Float Aligner," entered by Ed Ruppert, Southern California Gas Company.



Specific Gravity Control Assembly. *The purpose of this control equipment is to maintain any desired specific gravity of cooling tower basin water by automatic bleed-off control. The design and operation are indicated by the installation illustrated.*

Clarifier for Gauge Glasses on Hot, Dirty Oil. *This device was designed to keep gauge glass clean so that the level in the tank can be readily ascertained. As shown in the drawing, a ¼-in. condensing coil extends from the vapor line to the top valve of the gauge mount. Enough condensation takes place in this coil to keep the inside of the gauge glass clean above the liquid level*



"Snap Action Valve," entered by Harlan J. Wilson, Standard Oil Company of California.

"Westcott Front Bearing Extension Socket," entered by I. M. Greenfield, General Petroleum Corporation.

"Expanding Mandril," entered by T. G. McAlister, The Texas Company.

"Direct Reading Mercury Column Pressure Gauge Tester," entered by C. D. Gard and Hugh Multer, Union Oil Company.

"Metallic Packing Spring Hook," entered by C. A. Davis, The Texas Company.

"Boiler Gauge Glass Light," entered by T. T. Rissinger, Union Oil Company.

"Ice Chopper," entered by Jack Colvin, O. C. Field Gasoline Corporation.

"Thermo Syphon Heater," entered by Eugene Newman, Gilmore-Dabney, Inc.

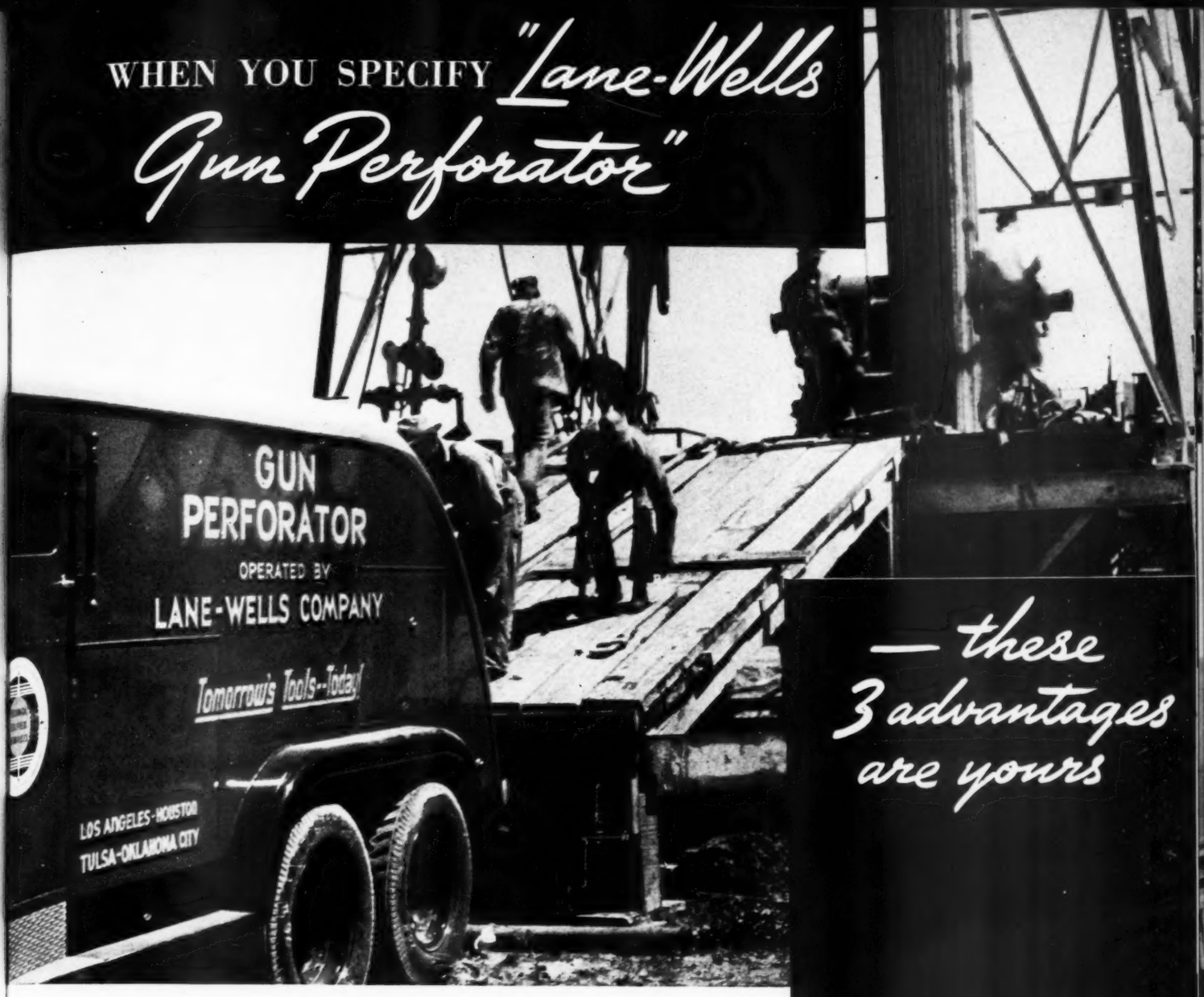
"Procedure for Determining the Taper of an Engine or Compressor Cylinder Without Use of a Micrometer," entered by C. A. Davis, The Texas Company.

"Cool Coil Partitions in Headers," entered by Eugene Newman, Gilmore-Dabney, Inc.

"Lube Oil Supply System," entered by A. L. Hendrickson, O. C. Field Corporation.

Drawings and photographs of a number of these "gadgets," together with a descriptive caption of the equipment are given herewith.

WHEN YOU SPECIFY *"Lane-Wells Gun Perforator"*



— these 3 advantages are yours

EACH LANE-WELLS GUN PERFORATOR UNIT embodies features designed to "get results" for the well operator with a minimum of down time. *Safety* for men and equipment is guarded by a five-point system of switches to prevent accidental firing. *Accuracy* is assured by calibrated measuring sheaves and sensitive depth-indicating devices. *Penetration* is the result of correctly balanced powder charges placed directly behind the bullet.

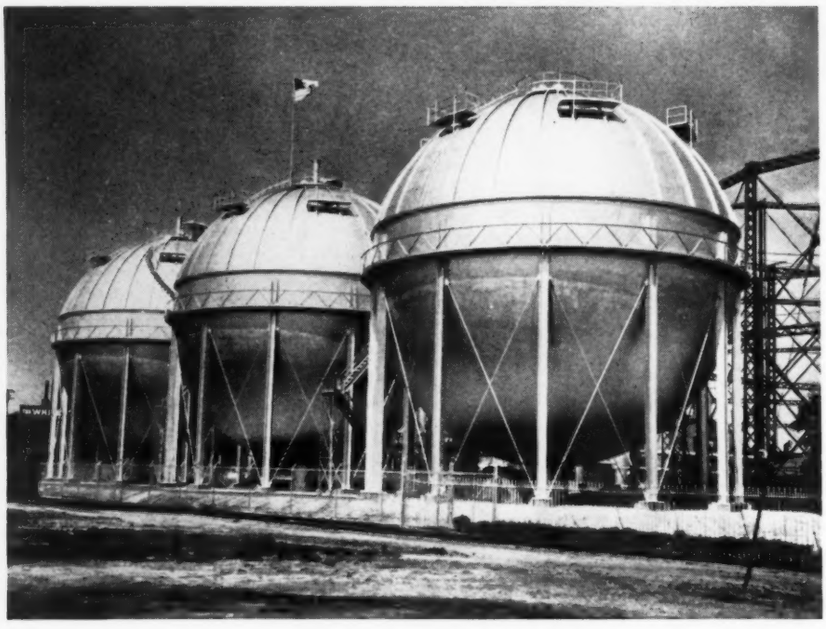
Lane-Wells crews are familiar with your field problems. They understand the importance of getting on and off the rig quickly so as not to hold up your own crew.

Lane-Wells has successfully completed more than 31,000 Gun Perforating jobs for more than 2800 oil companies, a record performance for both men and equipment. Check Lane-Wells operations at the well and you'll agree—"Lane-Wells gives you *more* for your service dollar."

THESE
GUN PERFORATOR APPLICATIONS CUT PRODUCTION COSTS

The complete story of Lane-Wells Gun Perforator as an economical aid to efficient oil production is available in Bulletin form. Write to: Lane-Wells, 5610 South Soto Street, Los Angeles, California.

P 652.



The three arc-welded gas storage spheres completed

Gas Storage At Low Temperature Increases Effective Capacity of Spherical Tanks

☆ **Sphere within sphere is cushioned with cork insulation**

by A. F. Davis

Vice-President, The Lincoln Electric Company

A NEW $1,000,000 gas storage project, which provides, in three spherical tanks, storage capacity equivalent to 150 conventional gas holders was made practicable by arc-welded construction at the plant of a midwest gas company, in Cleveland, Ohio.

The unique feature of this new project is the reduction ratio of 600 to 1 in liquefaction. In employing the cascade refrigeration process, the new plant stores the gas at extremely low temperatures (248 to 250 degrees below zero), thus introducing new problems in metallurgy.

The storage tanks consist of three arc-welded alloy steel spheres 57 ft. in diameter, 70 ft. high overall, each sphere having a storage capacity of more than 50,000,000 cubic feet.

Each sphere is, in reality, two spheres in one. Within an outer shell and separated from it by 3 feet of cork insulation is a nickel alloy steel sphere in which the gas is actually stored. This inner sphere actually "floats" upon the cork insulation, a feature which allows "working" during expansion and contraction.

Each sphere is supported by 12 columns fabricated of wide flange rolled steel sections. These columns have their flanges cut away at the top to conform to the contour of the shell. They are connected to the shell by fillet welds at junction of flange to the shell plating. Arc-welded to the column web is a T-bracket supporting a balcony that completely encircles the sphere.

All steel for the tanks was entirely formed in the shop. The shell of the sphere, consisting of 128 separately-formed segments, was fabricated by cutting steel plate and pressing it to

A. F. DAVIS

since his graduation from Ohio State University in 1914 with a degree of mechanical engineer in electrical engineering, has served The Lincoln Electric Company in various capacities —He was made vice-president in 1928 and secretary in 1938, and also serves on the board of directors—He is secretary of the James F. Lincoln Arc Welding Foundation, created in 1937 by the directors of The Lincoln Electric Company in honor of J. F. Lincoln, president of the company—Is a member of the American Welding Society, Sigma Alpha Epsilon, Eta Kappa Nu, and various local clubs and organizations.

The Job's so Big... The Time's so Short

Nothing like this has ever happened before! Never has America needed so much . . . from so many . . . in so short a time. Never has America needed power like she needs it today . . . dependable, highly productive power to forge the weapons of a strong and a free America. Yes, the need is big, the time is short, but Cummins Dependable Diesels have repeatedly demonstrated their ability to do the jobs where the need is big and the time is short . . . that's why Cummins Dependable Diesels have been so widely accepted for National Defense work . . . that's why you'll find Cummins Diesel power—whatever the job—doing it with "all-out" economy and dependability. Cummins Engine Company, 1516 Wilson Street, Columbus, Indiana.

MID-CONTINENT SUPPLY COMPANY • FORT WORTH, TEXAS

Distributors for Mid-Continent Territory

CUMMINS *Dependable* **DIESELS**

the proper curvature. It is interesting to note that all these segments were so accurately formed that no adjustments were necessary during erection. This is believed a remarkable feat considering the thickness of shell plating used and the form to which fabrication was necessary.

Erection of Spheres

Erection of a sphere began with placing the 12 columns upon concrete footings. Erection of the balcony and platform followed, then the center cylindrical section, utilizing temporary bolted connections. Then, working down from this center section, the segments of the sphere were placed, utilizing clip angle hangers to hold the segments in place. After all steel of a tier was in position, tack welds were made at various points followed by finish welding of the inside seams. The clip angles were chipped away at an early stage in the welding and the inner seams were welded in four beads. Welds were chipped away on outer surfaces and seal-welded. The thickness of the outer shell, consisting of mild rolled steel, is $\frac{7}{16}$-in. All welding was done under Hartford Insurance Inspection and all welders were qualified in accordance with the A.S.M.E. Code for pressure vessels.

With the lower half of the outer shell completed, application of the cork insulation was carried out, skewering the layers of cork together. Then followed application of asbestos paper, a nickel steel backing up strip for the welds on the inner sphere, (which was tack welded to the segments of the alloy sphere before erection), finishing with arc welding on the inner shell seams.

The lower half of the inner sphere, which is constructed entirely of nickel steel $\frac{3}{8}$-in. and $\frac{7}{16}$-in. thick, was then erected and welded. All welds were beveled to as small a vee as possible, the bevel not exceeding 30 degrees at any point. With completion of the two lower halves, the upper half of the inner sphere was then erected and welded, the upper half of the outer shell placed and welded, then the 3-ft. space filled with granular cork insulation. Erection of the upper portion of each sphere consisted of working from the center cylindrical section upward placing each tier of segments in order. This work was carried out utilizing temporary bolted clip angles until all steel was in position.

Erection of these three spheres represents a new industrial advance made practicable by welded construction.

The Gas Machinery Company, Cleveland, Ohio, was the general contractor for the project and Pittsburgh-Des Moines Steel Company of Neville Island, Pennsylvania, was the sub-contractor for the fabrication and erection. The welding was done utilizing the shielded arc process with most of the equipment supplied by The Lincoln Electric Company, Cleveland, Ohio.

Upper left—Seal-welding outer shell of gas storage sphere. Upper right—Overhead welding of bottom segment of outer shell. Lower left—Arc welding the seams of outer shell from inside sphere. Lower right—Arc welding a clip angle to inside of outer shell for holding scaffolding for welders.

OTIS TYPE C SAFETY VALVE

The new Otis Type C Tubing Safety Valve, instead of operating by flow velocity, is actuated by pressure differential. This change in the operating principle makes possible a positive and automatic action that is not affected by surging flow.

As long as the capacity of the surface choke is materially less than that of the openings through the Safety Valve, practically all of the pressure drop takes place at the surface choke—there being only a negligible pressure drop across the Safety Valve.

However, when the size of the surface choke, either because of cutting or of outside damage, approaches that of the openings through the Safety Valve, a pressure differential is set up across the Safety Valve which causes it to instantly close and shut off all flow through the tubing.

A new equalizing device provides a fast and safe means of reopening the Safety Valve when surface repairs have been made and flow is to be resumed.

Both the Safety Valve and Equalizing Tool are run and pulled under pressure on an ordinary steel measuring line.

Otis Service Units are available for the installation and service on all Otis subsurface tools.

OR SURGING FLOW

the Otis Type C Safety Valve provides positive protection regardless of damage to surface tubing connections.

OTIS PRESSURE CONTROL, INC.

DALLAS, TEXAS

Branches: Oklahoma City, Okla.; Houston, Texas; Hobbs, N. M.
Representatives: Otis Eastern Service, Inc., Wellsville, New York; Western Pressure Control, Inc., Los Angeles, California
Export Office: 74 Trinity Place, New York City

PRESSURE CONTROL · OTIS · SERVICE — EQUIPMENT

"Don't Kill Your Well" Call OTIS

LAUGH WITH BARNEY

"I wish we'd get a few shipwrecked sailors washed ashore," mused the cannibal chief. "What I need is a good dose of salts."

* * *

First Old Maid: Do you always look under your bed at night?

Second Old Maid: Yes, always.

First Old Maid: Ever find anything?

Second Old Maid: Only in the lower-priced hotels.

* * *

When a girl sneezes it's a sign she's catching cold and when she yawns it's a sign she's gotten cold.

* * *

Wisdom: Knowing what to do next.
Skill: Knowing how to do it.
Virtue: Not doing it.

* * *

A certain breeder of dairy cattle in one of the Southern states is distinguished for two things—the excellent quality of his cattle and his relentless insistence on his hired hands keeping busy. A negro came to him one day and applied for a job as milker.

"You don't look to me like a nigger that wants a steady job," replied the dairyman, eying him critically.

"Yassuh boss, Ah wants a stiddy job."

"Well, go to work, then, but I'm telling you, I don't like your looks."

The negro went, and found that he not only had to milk twenty cows, but care for the milk, wash the utensils, curry the cows and feed them, clean the stalls, and drive the cows to and from the pasture. In fact, he put in about eighteen hours a day. He was game, and stayed with it for two months. Then he gave notice.

"I knew it! I knew it," railed the dairyman. "I knew you didn't want a steady job, you no account rascal!"

"Yassuh, boss, Ah does," protested the darky, "but you's been layin' me off six hours ever' night."

* * *

An out-of-town bride and her groom arrived at the big city hotel on their honeymoon. The room they occupied was beautifully furnished with a pair of twin beds. Upon seeing them the bride began to cry and the groom said: "Why, my dear, what is the matter?" "I thought," sobbed the bride, "we were going to have a room to ourselves."

* * *

They have separate wards in insane asylums for men and women. They're not as crazy as you think.

The manager of an Aberdeen firm called the bookkeeper into his office.

"Macpherson," he said, "the accountant is leaving and I'm gaun tae gie you his job."

The young bookkeeper's face lit up with expectation.

"Thank you, sir," he replied. "And what will my salary be now?"

The manager shook his head.

"The same as you're gettin', but ye'll ha'e a hat-peg to yersel now," he replied.

* * *

Composer: I got tight in order to compose a new drinking song.

Friend: And did it work?

Composer: No, I couldn't get beyond the first two bars.

* * *

I think that I shall never see
A girl refuse a meal that's free;
A girl with hungry eyes not fixed
Upon the drink that's being mixed;
A girl who doesn't like to wear,
A lot of junk to match her hair;
Girls are loved by guys like me—
For who in the hell would kiss a tree?

* * *

"But you cannot withdraw your plea of guilty after the case has been heard. How is it you wish to reverse your plea now?"

"Well, you see, jedge, dat speech ob mah lawyer done 'vinced me I'se innocent."

* * *

There was the old farmer who noticed, while riding down a lonely road the other night, a young couple sitting in a parked car. The young man had a bottle in one hand and a girl in the other. "Harumph," said the farmer, "That must be one of them bottlenecks."

* * *

Parking Lots

She: Bill's the most dangerous kind of motorist there is.

He: Don't tell me he's a hit-and-run driver!

She: No, but that's what I have to do when he parks.

* * *

First Kangaroo: Annabelle, where is the baby?

Second Kangaroo: My goodness, I've had my pocket picked!

* * *

"Willie!"

"Yes, Maw."

"How many times must I tell you that the cuspidor is to spit in?"

"But, who would want to steal a Pullman ladder?" expostulated the conductor.

"I don't know, but she's gone," responded the porter.

At this juncture a passenger occupying an upper berth for the first time overheard the conversation, parted the curtain and generously remarked:

"Porter, you may use mine, I won't need it till morning!"

* * *

"Is there any truth in the report that MacTavish has bought the gasoline station?

"Well, I don't know for sure, but the 'Free Air' signs have been taken down.

* * *

"How's the wife?"

"Bad. She's got quinsy."

"Good heavens! How many does that make altogether?"

* * *

First Girl Hiker: I inserted an advertisement in our local newspaper recently under a box number for a male partner to accompany me on a fortnight's hiking trip.

Second Girl: How interesting. Did you have many replies?

First Girl: Yes, hundreds—but there was a terrible row in the house over it.

Second Girl: Good gracious, why?

First Girl: Father was one of the applicants!

* * *

A pompous Bishop of Oxford was once stopped on a London street by a ragged urchin.

"Well, my little man, and what can I do for you?

"The time o' day, please, your lordship."

With considerable difficulty the portly bishop extracted his timepiece.

"It is exactly half past five, my lad."

"Well," said the boy, setting his feet for a good start, "at 'alf past six you go to 'ell!" and he was off like a flash around the corner. The bishop, flushed and furious, his watch dangling from its chain, floundered wildly after him. But as he rounded the corner he ran plump into the outstretched arms of the venerable Bishop of London.

"Oxford, Oxford," remonstrated that surprised dignitary, "why this unseemly haste?"

Puffing, blowing, spluttering, the outraged Bishop gasped:

"That young ragamuffin—I told him it was half past five—he—er—told me to go to hell at half past six."

"Yes, yes," said the Bishop of London with a twinkle in his kindly old eyes, "but why such haste? You've got almost an hour."

BY HAVING ★C.C. AT THE CRITICAL CEMENTING POINT . . .

THE SHOE JOINT

BAKER CEMENT WASH-DOWN WHIRLER FLOAT SHOE

. . . And You Can Be Sure of CC (CEMENTING CONTROL) with a BAKER CEMENT WASH-DOWN WHIRLER SHOE

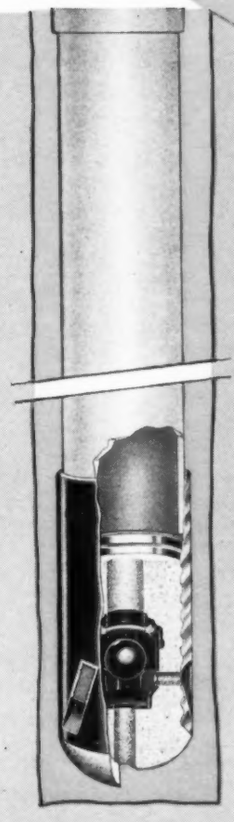
In cementing casing, operators realize the importance of having *complete control* of all above ground operations. In this connection, every step from "the mix" to "displacement" is carefully controlled.

But the importance of CEMENTING CONTROL does not stop there. How about control when the slurry reaches the point of discharge — the Shoe? That's where control is really important and that's where the Baker Cement Wash-Down Whirler Shoe plays its part in CEMENTING CONTROL!

It's the baffled whirler ports in a Baker Cement Wash-Down Whirler Shoe that do the trick. When the slurry strikes these baffled ports, a downward and then an upward whirling action results. This important whirling motion assures best possible distribution of a uniform body of cement entirely around the Shoe and the Shoe joint, thus reducing the hazard of channeling to a minimum AND SAVING A POSSIBLE COSTLY RECEMENT JOB.

REMEMBER, if you use a BAKER CEMENT WASH-DOWN WHIRLER SHOE, you have not only the *best cementing shoe that money can buy* but the shoe *best suited* for doing a successful cement job the first time!

★C.C. stands for CEMENTING CONTROL — A Baker Cement Wash-Down Whirler Shoe *Gives complete* C.C.



Provides 5 Important Features:

1. Ample Strength
2. Whirler Action for Washing-Down Bridges
3. Efficient Cementing (CEMENTING CONTROL)
4. Positive Acting BALL-TYPE Back Pressure Valve
5. Easy Drillability

PRODUCT NO. 120
Fig. L-28
Baker Cement Wash-Down Whirler *Float Shoe

**The Baker Wash-Down Whirler principle is also available in a Guide Shoe*

BAKER OIL TOOLS, INC.

Main Office and Factory: 6000 So. Boyle Ave.
Box 127 Vernon Station, Los Angeles, California
Central Division Office and Factory:
6023 Navigation Blvd., Box 3048, Houston, Texas
Export Sales Office: 19 Rector St., New York, N. Y.

Running Tour

WITH MEN IN THE INDUSTRY

A. B. BARNETT has organized his own company, Barnett Drilling Company. He was formerly connected with the Harbar and Cetal drilling companies.

MICHAEL L. BENEDUM, internationally known oil man and one of the industry's most venturesome wildcatters, has received an honorary degree from Allegheny College of Meadville, Pennsylvania.

GUIDO PIGGOT, JR., geological graduate from University of Tulsa, has joined the geological department of the British American Oil Producing Company and is making his headquarters in Houston, Texas.

E. B. REESER, president of the Barnsdall Oil Company, was presented with the "over 25-year pin" at a recent service award dinner in Tulsa, Oklahoma, by ARTHUR A. ODELL, acting toastmaster. Twenty-five year pins were given to ROBERT J. BEVINGTON, ELLIS J. CARTER, GEORGE A. CARTER, JOHN N. CULITON, WILLIAM F. CUTTING, RAY B. DAUGHERTY, JOSEPH H. HINTON, GEORGE C. NEYMAN, EARL C. RALSTON, SANDERS, CHARLES E. SHIPLEY, EDWARD M. SKEEHAN, RAYMOND A. SKEEHAN, FRANK TUCKER, and WILLIAM H. WINESBURG. Awards for 15 and 10 year service were also presented.

VIRGIL JONES, formerly in the production office of Phillips Petroleum Company, Breckenridge, Texas, is now at Bartlesville, Oklahoma. Jones succeeds ELMER BENDER, who has been transferred to Borger, Texas.

K. S. ADAMS, president of Phillips Petroleum Company, was recently appointed representative in the state committee to guide the United States defense savings in Oklahoma. Adams will represent petroleum interests in the committee.

WALTER VOIGHTLANDER, chief engineer for the Union Wire Rope Company, spoke on "The Care and Use of Wire Lines" at the American Petroleum Institute meeting held at the N-K Cafe, Seminole, Oklahoma, June 23.

CLYDE DELONG has been named operating manager of the mechanical sales division of The B. F. Goodrich Company, it is announced by W. S. RICHARDSON, general sales manager. He has been with the Goodrich organization since January, 1928. Delong succeeds F. A. LANG, who has been transferred to the managership of heel and sole sales department.

M. B. (JACK) JOHNSON, Perdue Tank Company, is now district manager with headquarters in Tulsa, Oklahoma, according to an announcement by J. F. PERDUE, prsident.

JAMES F. MCDONALD, Gulf Oil Corporation production engineer, has been transferred from Lyons, Kansas, to Tulsa, Oklahoma.

ERNEST KETCH, foreman for The Texas Company at Wayne City, Illinois, has been transferred by the company to Burrton, Kansas.

C. WENDELL BLACK, Stanolind Oil and Gas Company, has recently been promoted from petroleum engineer in the company's office at Houston, Texas, to superintendent of the gasoline plant in the Luby field near Bishop, Texas.

F. J. (BUD) BLUE, formerly of Jackson, Mississippi, has been transferred to Hobbs, New Mexico, where he will be manager for National Tank Company.

FRANK MONAHAN, well-known in supply circles, has joined Frick-Reid Supply Corporation and will handle sales in the wire rope division.

EARL D. ALLEN, formerly production superintendent for Nordan and Morris Oil and Gas Company, Escobas, Texas, is now with Bauer Brothers, Springfield, Ohio, manufacturers of Diesel engines.

R. HOUSTON FOSTER, 58, executive vice-president of Landreth Production Corporation, Fort Worth, Texas, died June 19 in a Rochester, Minnesota, hospital, where he had been seriously ill since an operation June 2. He was buried June 21 at McKinney, Texas.

HOMER T. LAMB, SR., who drilled one of the first wells on the Tea Pot Dome structure, died at the age of 63 at his home in Tulsa, Oklahoma, June 23. Lamb died after a long illness from a heart ailment. Oil men considered him as one of the most active in opening new pools. He is survived by his widow, a son, and two daughters.

A. G. CHAMBERLAIN, assistant secretary of Frick-Reid Supply Corporation, Tulsa, Oklahoma, is back at work after several months' illness.

J. C. WILKERSON, now at Midland, Texas, as gas-lift manager with the Wilson Supply Company, was recently transferred there from Los Angeles, California.

DIXIE MORRIS, Union Producing Company, Houston, Texas, has not and will not be transferred to Southwest Texas from Houston as was previously reported.

ROBERT E. MOYAR, June graduate of Colorado School of Mines with a petroleum engineering degree, is employed by Stanolind Oil and Gas Company as pumper. His present address is Macksville, Kansas.

VICTOR HORNER, drilling engineer with The Carter Oil Company, has been transferred from St. Elmo, Illinois, to Baker, Montana.

WALTER F. SWANTON, Jackson and Moreland Company, structural designer, was formerly division engineer with Core Laboratories, Inc. He has moved from Lafayette, Louisiana, to 472 Broadway, Cambridge, Massachusetts.

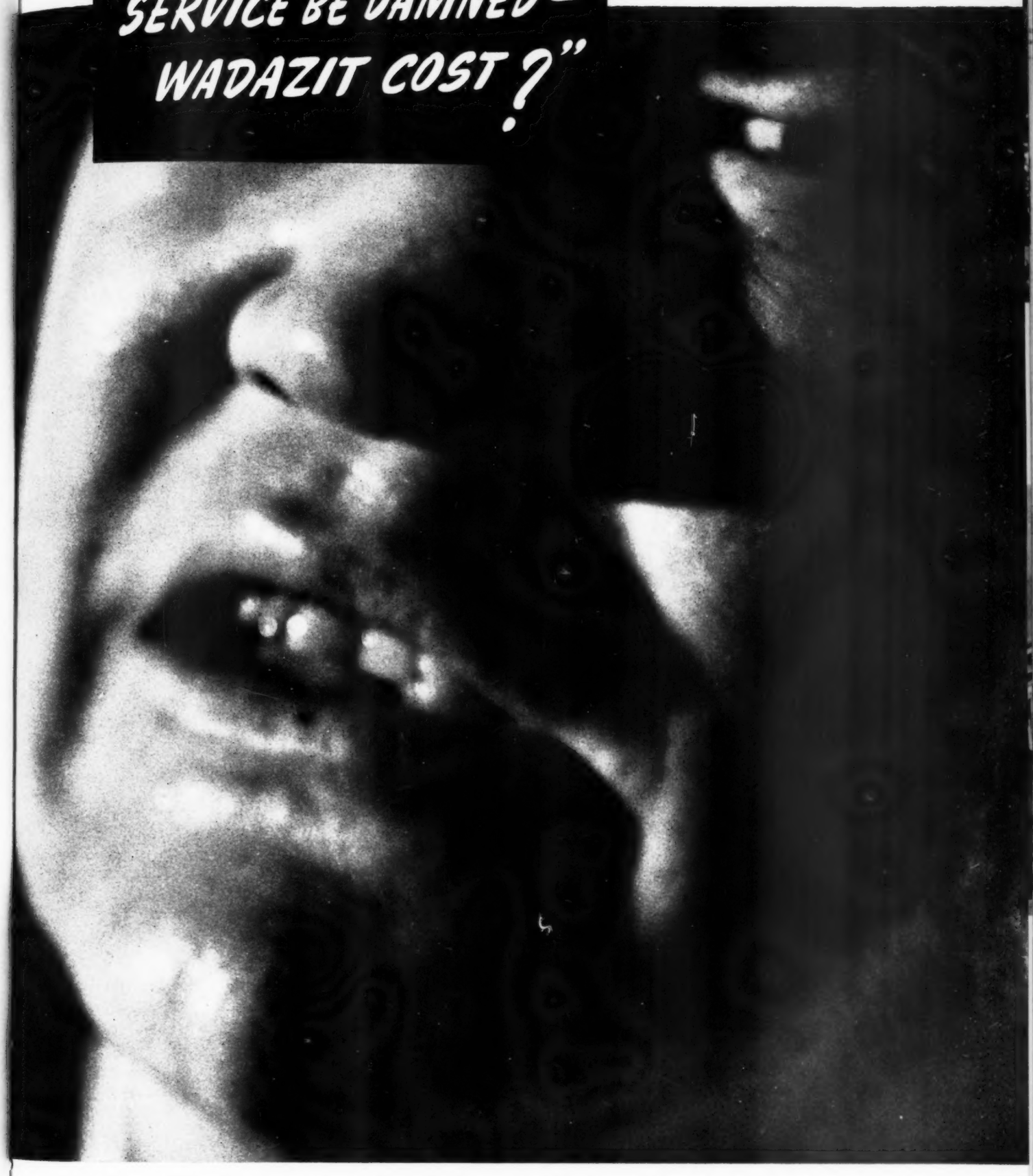
GEORGE O. YOUNG, formerly field engineer with Ford, Bacon, and Davis, Inc., is now a student at Oklahoma University, Norman.

W. H. ECHOLS is petroleum engineer for Standard Oil Company of Texas at Royalty, Texas. He was formerly with the Amerada Petroleum Corporation as assistant petroleum engineer and made his headquarters at Paradis, Louisiana.

CAPTAIN CHAS. GILL MORGAN, president of Morgan Engineering Corporation of Dallas, Texas, is now stationed in Washington, D. C. He can be addressed in care of the War Department Office, Chief of the Air Corps, Washington.

H. O. RUARK, Shell Oil Company production superintendent, has been transferred to Bristow from Stroud, Oklahoma.

"SERVICE BE DAMNED— WADAZIT COST?"



Everybody has said that at least once if they've lived very long; said it when they bought a hat, a suit, an automobile or a deep oil well plunger pump.

But,—in every case they've found that what it cost initially, was of the least importance in the long run. No way has ever yet been discovered of building quality into any product and selling it at a cheap price. Quality materials, inherently correct design and expert workmanship cost money; but when it comes to operation and maintenance, they save money.

Today buyer purchasers who pride themselves upon their smart purchasing, buy at a price,—but at a price consistent with quality. Over a period of time they get more for their money this way than any other.

Axelson SELLS AND *SERVICES* DEEP WELL PLUNGER PUMPS AND SUCKER RODS

CHESTER H. WESTFALL, who is president of the Mercury Drilling Company, is touring Kansas oil fields.

J. T. PARKER, chief clerk of construction at the Whiting refinery of Standard Oil Company (Indiana), has completed a 50-year service record with the company. Parker was given a gold watch by the president of Standard at the general offices in Chicago.

EDGAR DAVIS, Butler and Home Drilling Company superintendent, Dallas, Texas, has transferred headquarters from Albany to Abilene, Texas. Offices will be in the Mims Building.

J. A. BAILEY, petroleum engineer for Shell Oil Company, Inc., has been transferred from McPherson, Kansas, to Pampa, Texas.

EVERETT L. DAVIDSON, assistant engineer, United Gas Pipe Line Company, has transferred from the company's general office in Shreveport, Louisiana, to Dallas, Texas.

T. W. HAUGHT, superintendent for Ohio Oil Company at Falfurrias, Texas, is now superintendent at Bay City, Texas.

R. W. GRIBBLE has been transferred from Carlsbad, New Mexico, to Dallas, Texas. He is a superintendent for Southern Union Gas Company.

DEWEY T. ROSS, president of Dewey T. Ross Engineering Corporation, Tyler, Texas, is now in Washington, D. C.

E. E. DEBACK, vice-president, Stratton Pipe Line Company, Corpus Christi, Texas, delivered an address to the South Texas Geological Society on "A Discussion of Cycling and Equipment."

R. O. HARRIS is now district manager for McQueen and Clevenger, drilling contractors, which recently opened offices in Houston, Texas. Harris is a former tool pusher for Loffland Brothers.

H. L. RIGGS has moved to Mount Pleasant, Michigan, as superintendent of drilling for Lupher Drilling Company. Riggs moved to Mount Pleasant from Salem, Illinois, where he had been in charge of operations for the company.

K. A. KIMBELL was promoted from foreman to superintendent by Cities Service Gas Company, pipe line department, when he was transferred from Caney, Kansas, to Lyons, Kansas.

J. W. MCCRACKEN, United Gas Corporation, Wellington, Texas, will be transferred to Jackson, Mississippi, July 25.

CHARLES E. KNOX, JR., engineer for the Knox Refining Company, has transferred from Norman, Oklahoma, to Graham, Texas.

WILLIAM C. FASTNOW, Los Angeles, California, has recently been elected vice-president and chairman of the board of Kern Ridge Oil Company.

ALFRED S. WOLFNER, who was active in the oil industry in Europe, has recently landed in the United States. It will please his many friends to know

ALFRED S. WOLFNER

that he has arrived safely with his family in this country and expects to establish permanent residence here. His business plans at present are somewhat indefinite.

GEORGE B. JOURNEY was recently appointed manager of the Trans-Tex Production Company. His headquarters are in Houston, Texas.

W. D. MASON, Marcus Hook refinery manager, Sun Oil Company, has been presented with a 15-year service emblem.

JOHN G. PEW, Dallas, Texas, has been appointed to the board of directors of the Sun Oil Company. He is assistant to vice-president, J. EDGAR PEW. Three other appointments to the board include WALTER C. PEW, general sales manager; FRANK S. REITZEL, assistant to the president, and CLARENCE H. THAYER, manager of the engineering division, manufacturing department.

F. F. WRIGHT, Sinclair Prairie Oil Company, production department, has been transferred from Nowata to Ardmore, Oklahoma.

R. M. CHURCH, Oklahoma Natural Gas Company engineer, has been transferred to the Ardmore division of the company.

E. R. SWANSON is the new chairman of the National Safety Council's Petroleum Section, New England Division. Swanson is safety engineer with Colonial Beacon Oil Company, Everett, Massachusetts.

LAWRENCE OGDEN, formerly of Fort Worth, Texas, is now division engineer for Pure Oil Company, Olney, Illinois. He succeeds BART DELAAT, transferred to Chicago, Illinois, as assistant chief production engineer. Ogden will be assisted by C. F. TERREL, who was formerly at Chicago.

EMIL HUGUENIN, formerly deputy supervisor for the Division of Oil and Gas in the Los Angeles Basin, is now chief deputy oil and gas supervisor. Huguenin achieved his new post by competitive examination and will make his office in San Francisco, California. The position was formerly held by J. B. Case, deceased.

R. L. WALES and C. L. WHITEMAN, engineers for The Texas Company, are now in Beaver, Pennsylvania, having been transferred there from Effingham, Illinois.

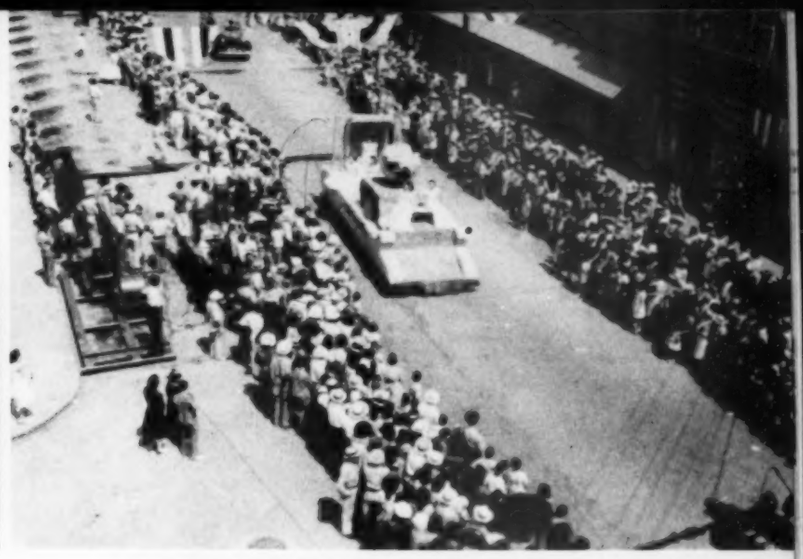
A. C. ANDREWS, who was petroleum engineer for the Stanolind Oil and Gas Company at Luby, Texas, is now superintendent of Stanolind's new cycling plant, now under construction, in the South Jennings field near Jennings, Louisiana.

JAMES W. VAIDEN, formerly manager of the natural gasoline and natural gas department of the Skelly Oil Company, Tulsa, Oklahoma, is now vice-president in charge of manufacturing. He will have executive supervision over the natural gasoline and natural gas departments and the El Dorado, Kansas, refinery and will continue to maintain his headquarters in Tulsa.

Graduating with a bachelor of science degree in chemistry from Alabama Polytechnic Institute in 1921, he entered the company in 1924 as a laborer at a gasoline plant in the Osage. Vaiden advanced steadily and was made manager of the natural gasoline and natural gas departments in 1934, which position he held until his recent elevation.

J. R. MOSER and O. G. HOUSER of Vickers Incorporated, Detroit, Michigan, have recently made an extended business trip through Gulf Coast and Mid-Continent fields.

Dr. Samuel T. Busey, of Deerfield, Michigan, owner of Busey-Armstrong No. 1, Arkansas' discovery well, and Mrs. Busey, at the side of the well.

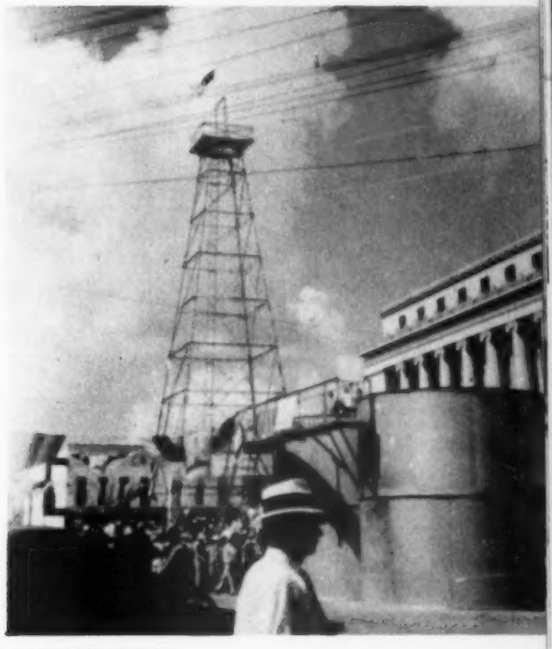


Magnificent floats representing various sections of the state added to the beauty of the occasion.

Twenty Years of Oil in Arkansas . . . Anniversary of Oil Discovery Celebrated in El Dorado, June 19, 20 and 21

Governor Homer M. Adkins praises the oil industry of Arkansas. A derrick floor was used as the speaker's platform.

Oil equipment was displayed on El Dorado's public square during the celebration.



A group of "old-timers" in Arkansas' oil history. Left to right: Frank Smith, Mayor of El Dorado during the boom, now fire chief; W. E. Patterson, El Dorado attorney, secretary-treasurer of the old Busey trust; Dr. Samuel T. Busey, the discoverer of oil in Arkansas; Sidney Felsenthal, El Dorado merchant, brother of the late Ike Felsenthal who was active in oil development; Mrs. Busey; Mrs. Smith; and Joe K. Mahony, prominent El Dorado attorney and oil operator.

Informal Poses Snapped at the Little International Oil Show, Odessa, Texas, June 20, 21, 22, 1941

1. This group of Halliburton Oil Well Cementing Company officials was among the early arrivals, flying to the Show by plane. Left to right, they are: R. A. Lyle, L. H. Lawrence, Charles Turner, Bill Coleman, C. P. Parsons, and R. E. O'Donnell.

2. J. H. Huey, left, director of the oil show, and H. H. Beagle, president of the Odessa Chamber of Commerce.

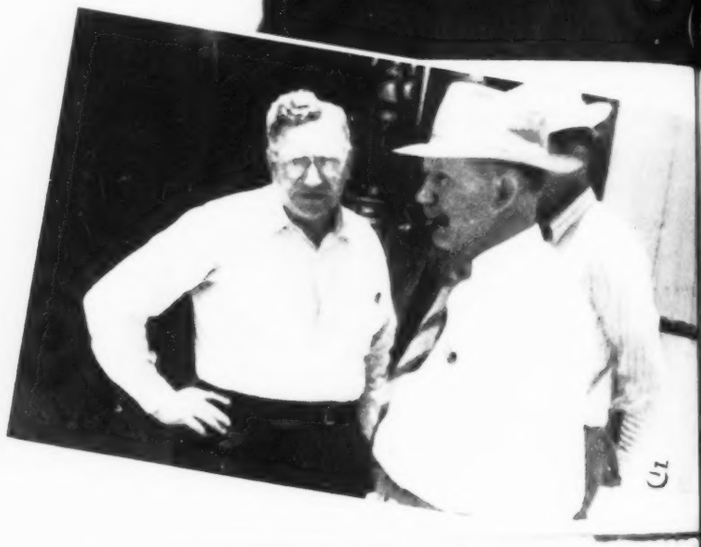
3. "Red" Griffith and George Clark of W. K. M. Company.

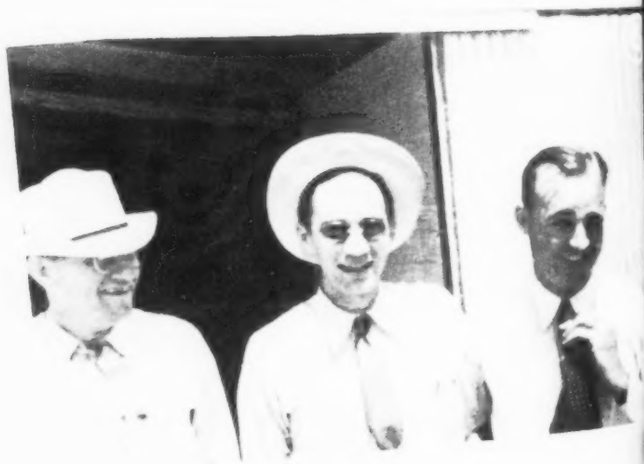
4. L. E. Murray, National Tank Company, who recently was transferred from Hobbs, New Mexico, to Midland, Texas, and promoted to district manager of Southwest Texas and New Mexico.

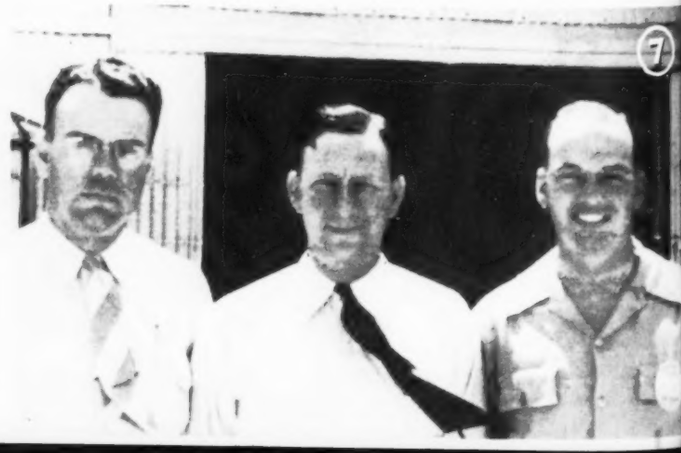
5. C. A. Mathey, C. A. Mathey Machine Works, Tulsa, Oklahoma, and W. S. Hiler, W. S. Hiler Co., El Paso, Texas.

6. J. M. Teague, H. E. Elder and Gene Teer, Cameron Iron Works, Inc., Houston, Texas.

7. Among those present from the Hughes Tool Company's Midland, Texas, office, were R. Z. Dallas, A. B. Cather and Stanley Moore.







M. L. Atkinson, superintendent of production, Phillips Petroleum Co., Odessa, was general chairman of the Show.

Jack Clemens, Corpus Christi representative for Martin-Decker Corporation.

Jack Magoffin of Byron Jackson Company, Tulsa, Oklahoma.

Barney McCullough, West Texas representative of Wilson Manufacturing Co., Inc.

Hugh Trimble, Texas Steel Company, Fort Worth, Texas.

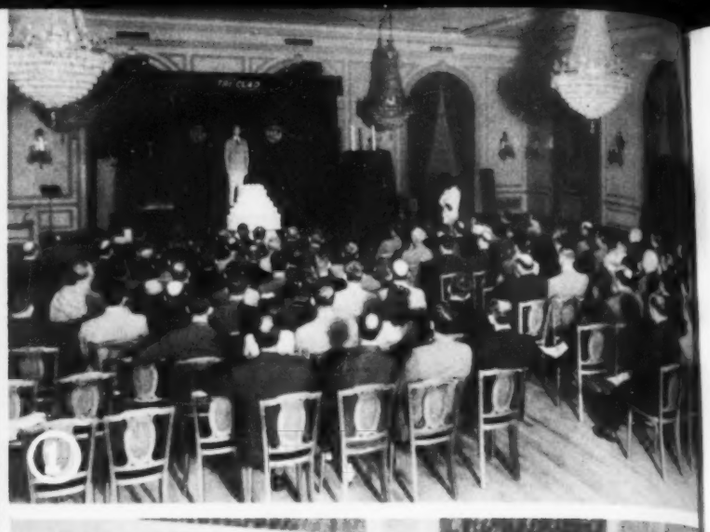
"Red" Knight, left, West Texas representative, and L. L. Rector, president, Rector Well Equipment Company, Fort Worth, Texas.

Al Pranger, Guiberson Corporation, Dallas, Texas.

Holt McWorkman, S. M. Jones Co., Tulsa, Oklahoma.

John N. Martin, John N. Martin Co., Tulsa, Oklahoma.

R. K. Davies, vice-president of the Standard Oil Company of California, who has been appointed deputy oil coordinator by the Federal Government to serve under Petroleum Coordinator Ickes.



General Electric Company sponsors celebration throughout Southwest of 100th birthday of invention of electric motor, and introduces a new line of induction motors, the Tri-Clad. (1) At Dallas, Texas, J. A. Spencer, master of ceremonies, starts show after 100 candles have been lighted on birthday cake. (2) At Fort Worth, Texas, A. H. Keen of GE explains the Tri-Clad motor.

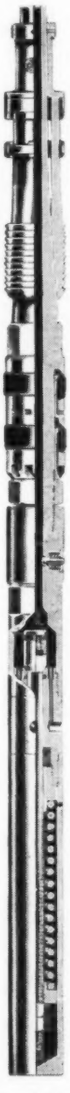
Frank Brown, export representative, winner of the golf tournament held recently by New York Chapter of Nomads at Oakland Country Club, Long Island.

Among those who participated in golf tournament held by New York Chapter of Nomads were, left to right: J. H. Baird, Byron Jackson Company; Val Wittich, export representative; John Hicklin of Trinidad; and Bill Campbell, Petroleum Machinery Corporation.

MACHINERY and EQUIPMENT

Type C Safety Valve

THE purpose of the Otis Type C Tubing Safety Valve is to provide a positive and automatic subsurface shutoff the instant damage occurs to the tubing connections regardless of whether this damage is caused by flow cutting or an outside impact. The principal advantage of this tool over the company's Type B Safety Valve is that it is effective in surging wells and will not prematurely close due to the action of heading flows.



In principle, this tool is merely a valve held in an open position by the compression of an adjustable coiled spring. The valve is actuated by a pressure differential across the valve stem that necessarily must overcome the mechanical load introduced into the spring before the valve will close. Flow through the tool is limited to openings immediately below the valve and seat. A packing element around the valve stem forces all flow through these openings. Consequently, as long as the surface choke is smaller than the combined openings through the safety valve, a negligible pressure drop is created across the valve stem. When the size of the surface choke, either because of cutting or outside damage, approaches that of the openings through the safety valve, however, a pressure drop is set up across the valve stem, causing the valve to suddenly snap closed.

The initial compression placed in the valve spring usually is around 500 lb. per sq. in., however, for wells with comparatively low flowing pressures 100 to 150 lb. per sq. in. may be used. This regulating is done in the field merely by adjusting the nuts on the bottom of the valve stem to the calculated position shown by a calibration chart.

Prior to the origin of this tool, all safety valves were actuated by an increased flow velocity, the manufacturer states. Consequently, in wells that flowed by surges the velocity type valve sometimes closed prematurely whenever an exceptionally heavy surge occurred. The new Type C Safety Valve is closed only by a pressure differential that is in excess of the mechanical load put in the spring to hold it open. Therefore, it is not affected by fluctuating velocities regardless of the severity of the surging. This is possible because there is actually very little pressure drop created across the valve by a surging flow action.

Once the tubing connections are damaged and the safety valve closed, all the well pressure acts against the area of the valve seat to hold it closed until the connections are repaired. To re-open the safety valve, a special equalizing tool is run in the tubing on an ordinary steel measuring line. This tool opens a small bypass valve in the side of the safety valve and permits the pressures to equalize across the safety valve and cause the spring to force the main valve open.

The Type C Safety Valve is run and pulled under pressure on an ordinary steel measuring line and requires only a few hours to complete the operation.

Dayton Cog-Belt

A NEW type of V-belt, with an unusual driving surface for either flat pulleys or V-grooved pulleys, is being introduced by The Dayton Rubber Manufacturing Company, Dayton, Ohio. This new V-belt, marketed under the name of "Dayton Cog-Belt," is designed around a new type of cog construction principle on the inner surface of the belt. Not only does this construction provide greater flexibility and longer belt life when flexing around small pulley diameters, but for V-flat drives it applies the scientific principle of increasing traction by means of a non-skid design, the manufacturer asserts. Just as scientific tire tread design prevents slipping on smooth roads, so does the patented cog construction provide greater grip and less slip on smooth flat pulley surfaces, it is pointed out. Likewise, when riding in grooved pulleys, this new belt provides added gripping power with die-cut raw edge sides that present the same undistorted driving surface to the pulley regardless of side wear, it is stated.

This new belt is being manufactured in all standard lengths in A, B, C, D, and E cross-sections, and in perfectly matched sets for multiple drive service.

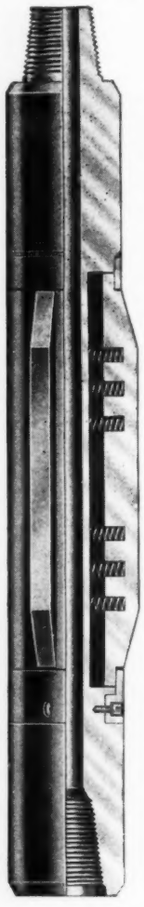
Brewster Combination Hook-Block

TO overcome the lack of derrick space often encountered in portable rigs, The Brewster Company, Inc., of Shreveport, Louisiana, has designed and developed the short coupled combination hook-block shown here. This new streamlined piece of equipment is identified as Model H-50-B.

The H-50-B Block incorporates 3 manganese steel sheaves 22 in. in diameter. A 2-piece cover streamlines the block and enables all pins and bolt heads to be countersunk. Line guide around sheaves reduces rigging time to a minimum and makes it unnecessary to remove the guard covers when stringing the block. Side sway is reduced by mounting sheaves on tapered roller bearings. Center pin is 3¾ in. diameter, two bottom pins are 1¾ in. diameter. The hook is spring-loaded type with 4 in. travel, forged from manganese chrome moly steel and swivels on roller thrust bearings. A locking device holds the hook firmly in either of four positions. Overall length only 68 in., width 89 in., depth 14 in. Maximum safe load capacity 100,000 lb. Approximate weight is 1500 lb.

Rotary Casing Scraper

A NEW design of scraper for cleaning the inside walls of pipe in a well has recently been developed by Baker Oil Tools, Inc., Box 127, Vernon Station, Los Angeles, California. This tool, the Baker Rotary Casing Scraper, is used to remove the sheath or thin wall of hardened cement that usually adheres to the inside walls of the casing even after a maximum gauge bit has been employed to drill-out the cement tailings left in the lower end of a cemented string of pipe. It is also adaptable for the removal of most any kind of substance or material, such as paraffin, that may adhere to or become deposited on the inside walls of the pipe. This makes the scraper suitable for thoroughly cleaning the inside of casing or liner for any purpose.



A feature of this rotary casing scraper is its simplicity, both in construction and operation. No tripping or other special procedure is necessary for its use; it is merely placed between the bit and the drill collar and run in the well. It consists principally of a body in which three long, reamer-type, hard-faced blades are mounted in a vertical position, as shown in the accompanying illustration. These blades are at all times pressed outwardly against the pipe walls by a number of coil springs but are prevented from extending beyond a maximum expanded position by retaining segments at the top and bottom of each blade. The three blades thus form an expansible reamer and the self-adjusting and equalizing construction insures a uniform contact with the walls of the pipe to give a smooth, clean, scraping action.

Being provided with a tool joint pin on its upper end and similar box on its lower end, the connection between the drilling bit and the drill collar is merely broken and the scraper there inserted. As the springs press the blades outwardly at all times, the casing scraper is run down the hole with the blades riding against the inside walls of the casing. When the section of pipe to be scraped or cleaned is reached, the drill string is rotated as in normal drilling. The scraper then automatically cleans the inside walls of the pipe as it follows the bit down. The blades will not only automatically adjust themselves to all pipe thicknesses but will compress sufficiently to run through joints of internal upset pipe, it is stated.

Thermoid Adds to Line of Industrial Rubber Products

THERMOID Rubber, Division of Thermoid Company, Trenton, New Jersey, announces an important addition to its industrial rubber products program.

In addition to the line of V-belts—both multiple and fractional horsepower—which Thermoid has been selling for the last three years, the company is now offering a complete line of V sheaves and pulleys. This addition makes it possible for Thermoid distributors to offer complete V-belt drive service and equips them to engineer and install V-belt drives from ¼ hp. to 1000 hp.

Complete information on Thermoid V-belt drives is contained in a simplified, easy-to-use, 80-page engineering manual that covers Thermoid multiple and fractional horsepower V-belts and drives.

With the addition of V-belt drives, the Thermoid industrial rubber products line now includes all types of

transmission belting, conveyor and elevator belting, wrapped and molded hose, packings, industrial brake linings, rubber-covered rolls, and pulley lagging.

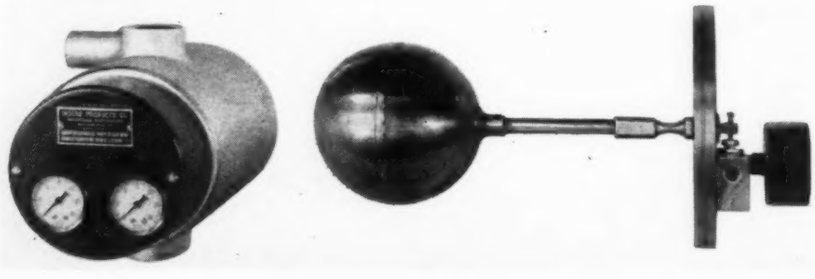
Liquid Level Controller

A NEW liquid level controller has been developed that eliminates the need for packing glands, pressure-tight shafts or any electrical system for transmitting motion through the wall of a pressure vessel to the atmosphere, it is announced by Moore Products Company, 3629 North Lawrence Street, Philadelphia, Pennsylvania.

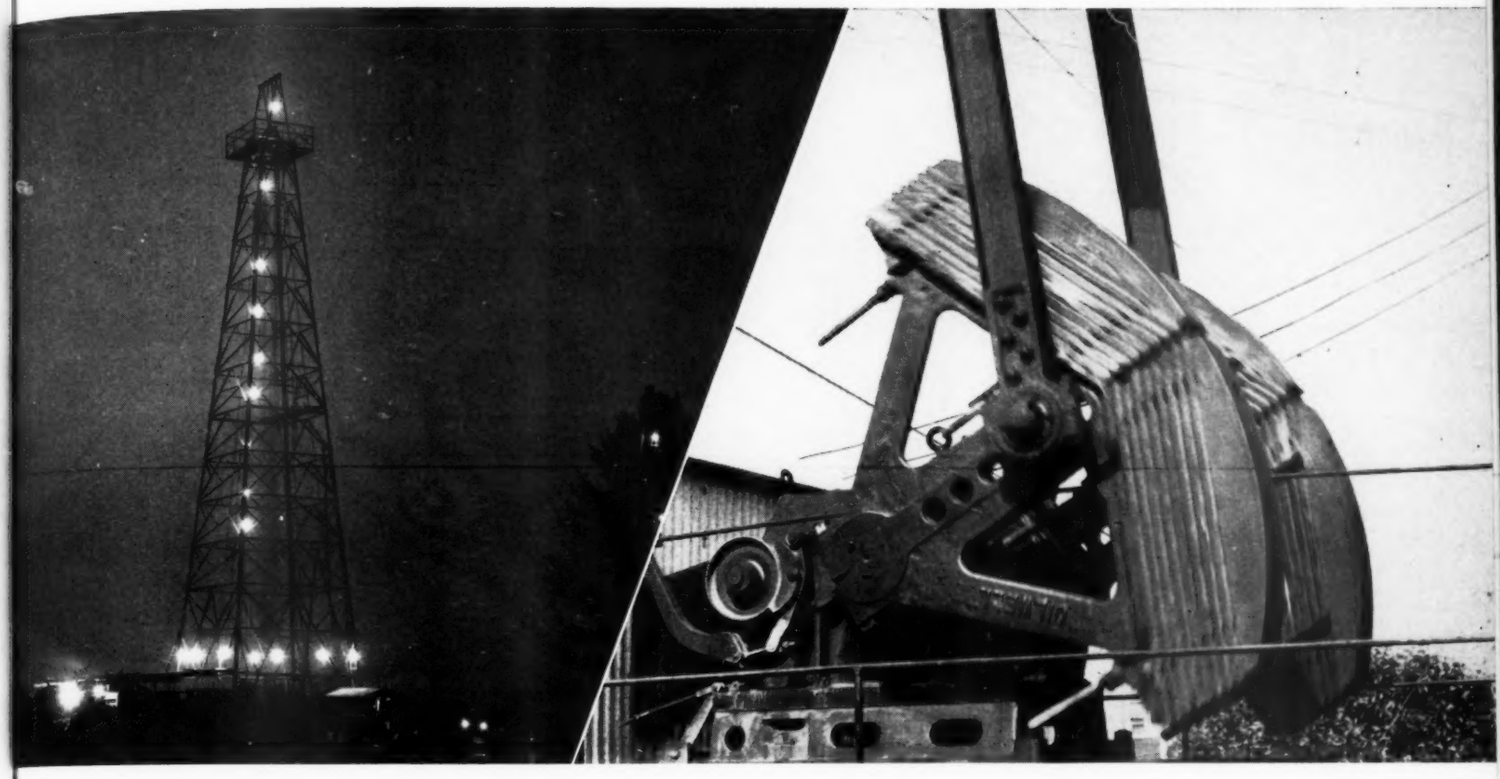
The construction consists of a 4 in. diameter float and shaft connected to a flattened member, similar to a Bourdon tube, which is fastened to a supporting flange. A flat lever inside this tube and fastened to the float shaft end, connects with the air pilot, or micro-switch for controlling the liquid level. A change in buoyant force on the float flexes the flattened tube and through the flat lever transmits the float motion to atmospheric pressure.

The sensitivity is such that a change in level of ½ in. of water will result in a full 15-lb. change on the transmitted control pressure. The flexing of the flattened tube is at all times within its elastic limit and tests have shown that with a special float the equipment will operate at 5000 lb. per sq. in. pressure with only about a 20 percent reduction in sensitivity, it is stated. By using slightly larger weighted floats, this controller is said to have been used successfully for interface level control where the difference in specific gravity is as low as 0.07.

The materials used may be changed to suit corrosive liquids, and as there are no rotating or sliding parts, all exposed surfaces may be silver or gold plated, or rubber covered to resist the action of various chemicals.



OUT OF THE NIGHT . . . AND THRU THE DAY



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PETROLEUM ELECTRIC POWER ASSOCIATION

Rubber-Tread Impact Troughing Belt Conveyor Idler

FOLLOWING closely on the heels of the announcement of a new Link-Belt rubber-tread return run

idler for belt conveyors, Link-Belt Company, Indianapolis, now announces a new, troughing type rubber-tread impact idler designed to absorb the shock of receiving heavy, lumpy, rough materials at the loading point.

It is pointed out that the cushioning effect of the rubber-to-rubber contact between belt and idler will prevent cutting, bruising, scuffing of belt; and protect the bearings and framework from shock, thus prolonging the life of both the belt and the idler. Other features asserted for the new idler are: (1) less breakage of fragile material such as coke, friable coal, etc.; (2) cleans the belt and prevents building up of material; (3) withstands corrosion and abrasion.

Molded rubber-tread rolls, 6 in. diameter, are firmly secured to a "Friction Fighter" roller-bearing-equipped tube by set screws through malleable iron spacers that clamp over reinforced rubber hubs. These rolls are said to cushion even the heaviest blows.

The new idlers are available for belt widths of 14 to 60 in. Larger diameter rolls can also be supplied, as well as rubber-tread impact rolls for flat-belt conveyor idlers.

Further data will be found in a new Link-Belt Folder No. 1793, sent to any interested reader on request.

INSURING TOMORROW'S WORK

with today's plans

Today every ounce of energy . . . every pound of material . . . every dollar of our resources is behind the national preparedness program: To defend Americans—their principles—their way of living—their jobs.

Plans for tomorrow must protect and permanently secure the advantages gained by the work in which we are engaged today . . . protect it with improved facilities . . . for making better products . . . for less money.

New developments incorporating Twin Disc Hydraulic Drives are making past production records obsolete. Twin Disc Torque Converters are increasing the daily output in logging camps 15% to 20%. In the oil fields, Hydraulic Drives are speeding up drilling, lengthening the life of tools and equipment. Railcars equipped with Torque Converters are setting up new standards for economy, speed and passenger comfort. If you employ an internal combustion engine to power your equipment, you should investigate Twin Disc Hydraulic Drives. Ask for Bulletin P-132. TWIN DISC CLUTCH COMPANY, 1370 Racine Street, Racine, Wisconsin.

Illustrated: Left, Hydraulic Torque Converter and right, Hydraulic Power Take-off

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U.S. PAT. OFF.

Brown New-Matic Transmitting System

THE Brown Instrument Company, Philadelphia, Pennsylvania, announces the development of the Differential New-Matic Transmission System.

Differences in temperatures, flows, levels, pressures, etc., can be accurately and conveniently measured by the Brown New-Matic Transmitting System, it is stated. This system consists of two measuring elements equipped with pneumatic transmitters, each of which delivers an air pressure proportional to the measured variable, and a differential pressure detector employing a mercury-filled U-tube and a float actuating a recording or indicating pointer.

Where the differences are large, a wide range can be covered. When the differences are small, minute changes can be easily observed. The two transmitters may be as much as 500 ft. apart, yet indications will only lag 20 seconds for full scale movement. The actual values of either or both of the measured variables may also be recorded on the chart of the differential pressure detector.

Bulletin No. 94-4 fully describes this system. Large, clear photographs show the transmitter, simple float mechanism, etc. Diagrams indicate how this system is applied to specific applications. A copy will be sent to any readers who may request it. Address: The Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, Pennsylvania.

R. M. Cleveland Succeeds W. A. Finn

Worthington Pump and Machinery Corporation announces the appointment of R. M. Cleveland, a veteran of 24 years' service with the organization, as manager of its Boston office. He succeeds W. A. Finn who has been called to active duty with the Navy in the rank of lieutenant.

Silver Anniversary of Francis H. Payne

In celebration of his fiftieth anniversary with American Meter Company, Francis H. Payne was tendered a sur-

Mr. McKean makes the presentation to Mr. Payne

prise testimonial on June 20 at the Kahkwa Club in Erie, Pennsylvania.

From the company's factories and sales offices all over the country, 46 of its officers and members gathered to honor the man who not only is president of American Meter Company but has an unbroken record of half-a-century as manager of its important Metric Metal Works.

In memory of the occasion a fine old antique grandfather's clock was given him, the presentation being made by Norton McKean, vice-president of the company and manager of its D. McDonald and Company Works in Albany, New York. McKean himself has been with the company since 1913.

A director of American Meter Company for many years prior to his election as vice-president in 1923, Payne was made president in 1936.

He is a graduate of the Titusville High School, of the Hill School of Pottstown, Pennsylvania, and Princeton University, class of 1891.

Celebrate 100th Birthday Of the Electric Motor

More than 150 representatives of the leading industrial concerns and power companies from North and East Texas, Dallas, and vicinity attended a combination birthday and christening party June 13, at the Crystal Ballroom, Baker Hotel, Dallas. Sponsored by the General Electric Company, the program included a celebration of the 100th birthday of the invention of the electric motor. There was also a ceremony to christen General Electric's new line of induction motors, called Tri-Clad.

After reviewing the interesting history of motors by means of a huge G-E "family album," local representatives of the General Electric Company as well as factory representatives from the G-E plant in Schenectady, New York, introduced the new Tri-Clad motor line to the audience. Slides, charts, and working models were used by a corps of experts to demonstrate the new motor.

In commemorating the birthday of the motor, company officials described it as "the product which has helped to make America the greatest industrial country in the world—the motive force that is today helping tirelessly to make America the arsenal of the democracies."

Two General Electric units, similar to the one that visited Dallas, are on the road. Meetings are being held in the principal industrial centers all over the country.

Each unit travels in two large trucks, carrying its own production manager, stage hands, and cast, as well as complete stage, curtains, lighting effects, public address system, stage properties, and exhibit booths.

TRACTION

With two driving axles under the load instead of one, you are able to haul bigger payloads.

With double the tractive effort obtained with the THORNTON two-speed gearcase, you can keep going when conditions are tough.

You get more flexibility with two transmission ratios—one for power, one for speed.

With THORNTON "Walking-Beam" spring design less shock reaches vehicle and load.

YOU SAVE MONEY because your initial investment is reduced 25 to 40%. Users report operating and upkeep costs 30 to 50% lower.

Let us show YOU how to save money with a THORNTON unit engineered for YOUR job.

Successful in scores of industries!

THORNTON TANDEM CO.
8733-8779 GRINNELL AVE. DETROIT, MICH.
Manufacturers also of the THORNTON automatic-locking DIFFERENTIAL
"When you need TRACTION you need THORNTON"

Los Angeles Nomads Hold Business Session

The regular monthly meeting of the Los Angeles Chapter of the Nomads held at the Los Angeles Athletic Club, June 18, was confined to the transaction of business of the organization. A discussion of membership and the election of new members preceded the dinner after which Ted Sutter, president of the National Board of Regents, made a report on the activities of the Nomads throughout the country in general and on the meeting in Tulsa during the A.P.I. at which visiting members from all the chapters met with the Tulsa Chapter.

Among the plans made for future activities of the Los Angeles Chapter were those for a combination barbecue and golf tournament to be held in August and a meeting at San Francisco during the A.P.I. convention in November.

After raising three associate members to regular membership because of recent foreign trips made, five new regular members and eight new associate members were elected. The three men moved up to regular membership were Tom Murphy of Martin-Decker Corporation, who just returned from Canada; Roland E. Smith of Grant Oil Tool Company, who is at present in South America, and Tom Martin with Bob Eiche, who will soon be back from a trip to South America. The new regular members elected were T. M. Johnston, of M. O. Johnston Oil Field Service Corporation, who recently returned from a South American trip; Ralph W. Marshall, now with Drilling and Exploration Company, who at one time was manager of the Oil Well Supply Company branch in Canada; Web Wilson of Web Wilson Oil Tools Company; J. J. Siegel of Kobe, Incorporated; and William McGraw of Western Pipe and Steel Company. Wilson, Siegel and McGraw all spent considerable time in Mexico and Canada with previous oil equipment connections. The associate members elected were men who have been on the waiting list for a long time but who could not be previously taken into the Los Angeles Chapter because the associate membership quota was full. They were John B. Isaacs of Hughes Tool Company; Ralph Clemens of Mission Manufacturing Company; Earl E. Cater of H. C. Smith Oil Tool Company; Reed O'Neil of Reed Roller Bit Company; Earle M. Boggess of Baker Oil Tools, Inc., and Stewart F. Remmel of Byron Jackson Company.

Grizzly lined steel bands for all types of brakes and to fit any drum diameter are carried in stock by leading supply houses for quick delivery to your rig. Ask your supply dealer for detailed information.

For longer, better rotary brake service use the Grizzly Rotary Brake Block Lining Band Exchange. Steel bands, lined with the correct Grizzly lining for your particular drawworks, are delivered to your rig ready for installation. Just remove the old bands and replace with these new Grizzly lined bands. All Grizzly bands are rolled to correct curvature to fit the drum, insuring perfect contact of lining and perfect braking performance. Saves time and labor.

E. M. SMITH COMPANY

600-650 South Clarence St., Los Angeles, California, U. S. A.

Complete Stocks Maintained in Our Warehouses At:

407 Velasco Street, Houston, Texas 1621 East Yellowstone, Casper, Wyo. 1008 S. E. 29th Street, Oklahoma City, Okla.

Export Office: Continental Emsco Co., 30 Rockefeller Plaza, New York City.

Distributed by Leading Supply Companies.

GRIZZLY ROTARY BRAKE BLOCK LINING EXCHANGE

Falk Corporation Announces Promotions

The Falk Corporation, Milwaukee, Wisconsin, announces the appointment of W. L. Schneider to the position of vice-president of sales, T. F. Scannell to sales manager, and J. B. Kelley to assistant sales manager.

Schneider was a graduate from Marquette University in 1925 and began with the Falk Corporation as a sales estimator. He has held successive positions as a sales engineer, assistant sales manager, and sales manager. While fulfilling his new duties as a vice-president of the Falk Corporation Schneider will continue in the supervisory capacity as director of sales.

Scannell, who succeeds Schneider as sales manager, will be responsible for the active sales of all Falk products, except those under the jurisdiction of the Foundry Division. He is a Yale University graduate in the class of 1918. During the World War he served as an Ensign in the U. S. Navy. He spent some time with the Chain Belt Company and joined the Falk Corporation in 1928 as St. Louis representative, later becoming district manager of the southwest territory. Since April, 1940, he has been assistant to the sales manager in Milwaukee.

Kelley was a graduate of Marquette University in 1927. Since that time he has been with the Falk Corporation first as an apprentice and later as an estimator, salesman, and district manager in Cincinnati, Ohio. In recent years he has been in charge of the Falk Corporation's flexible coupling business.

Jack Axelson and Miss Marilyn Bennison Married

Announcement was made recently of the marriage of Jack L. Axelson, the son of D. F. Axelson, vice-president of the Axelson Manufacturing Company, to Marilyn Bennison, daughter of Arnold D. Bennison of the General Petroleum Corporation of California.

JACK L. AXELSON

The couple was married at the First Congregational Church in Los Angeles, California, and left following the ceremony for a short wedding trip.

Jack Axelson, whose grandfather, C. F. Axelson, was one of the founders of the Axelson Manufacturing Company, is a third generation member of the family to start out learning the oil-well pump and engine lathe business in the plant. After his graduation from Whittier College two years ago, Jack began work in the plant foundry and has since been transferred to the lathe assembly department where he has been working on the assembly of Axelson lathes for government defense orders.

On their return the couple will make their home in Whittier.

Appalachian Meter School Proceedings Published

The proceedings of the third annual Appalachian Gas Measurement Short Course have been printed in book form and have now been distributed to all who were registered at the 1940 meeting.

This third meeting of this school, jointly sponsored by the University of West Virginia and the Public Service Commission, was held in Morgantown last August with R. W. Hitchman, of the United Fuel Gas Company, serving as chairman of the Meter School Committee. More than 400 gas men from the eastern United States attended.

The dates for the fourth meeting of this school, which will be conducted under the chairmanship of A. F. Kraus, of the Peoples Natural Gas Company of Pittsburgh, have been announced as August 18, 19, and 20, 1941.

Kraus and his committee workers are now developing the program in which nationally known authorities in the gas industry will participate.

The proceedings of the 1940 school cover papers read and discussed on the general theme, "The Theory and Practice of the Measurement and Control of Gases." A limited number of extra copies are available, which can be obtained at $1.00 the copy by addressing G. R. Spindler, director of the school at West Virginia University, Morgantown, West Virginia.

I.P.E. Options Expire August 15

The expiration date for options granted exhibitors at the International Petroleum Exposition in 1940 for the same space in the 1942 Tulsa show is August 15, according to an announcement by Wm. B. Way, general manager.

With the number of exhibitors who have already signed contracts and taken up their options having now reached 75, Way anticipates a rush on additional contracts in the next 30 days.

"Two to five new contracts are being received daily," he stated. "Approximately 50 percent of those sending in contracts are paying for their space in advance."

Nearly 58 percent of the available space for the May 16 to 23, 1942, Exposition has been reserved by approximately 175 companies. The task of arranging space for new firms and for those in the 1940 show who asked for increased space will begin following the expiration of options on August 15.

The Petroleum Engineer

Is Available Through Subscription Only

IT IS NOT FOR SALE
ON THE NEWS STANDS

NEW FEATURES ★ NEW DESIGNING ★ NEW ECONOMIES

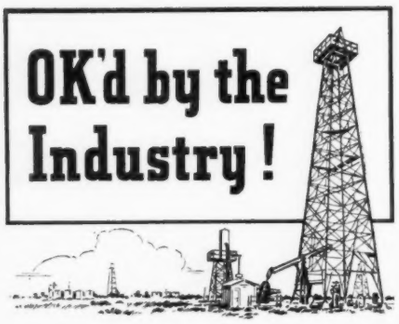
FOR ROTARY MUD RECONDITIONING

Here's one of numerous installations of the new dual hookup of Link-Belt NRM-124 vibrating mud screens that's seeing plenty of action these days. This latest development features two 24"x48" screens mounted on skids as one unit, with one mud collecting tank and inlet chute. A single motor or turbine drives both screens. Write for Folder No. 1872-A.

LINK-BELT COMPANY
Philadelphia, Houston, Dallas, Los Angeles, New York, Toronto
Sold by most supply houses.
8547

LINK-BELT MUD SCREEN
THE VIBRATING SCREEN THAT HAS EVERYTHING

OK'd by the Industry!



Hundreds of oil field and pipe line installations prove that Ludlow Valves are OK'd by the industry. And every year finds many more Ludlow Valves going into service.

Study the four points in the panel below. They explain the principle of valve construction that Ludlow developed and perfected — they point out the definite benefits that Ludlow Valves offer. Don't take a chance — specify Ludlow for longer life and trouble-free performance.

Ludlow Valve with forged steel welding flanges. Ludlow Valves are furnished in any desired sizes and types for oil field and pipe line service. Write for full information — no obligation, of course.

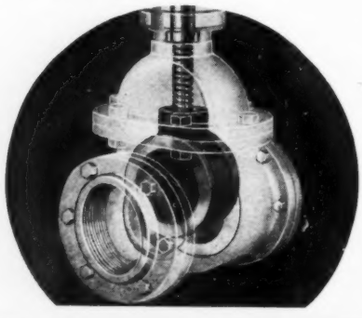
LUDLOW PARALLEL SEAT DOUBLE GATE VALVES

Smooth, positive operation. Gates positioned directly opposite ports before wedging and entirely unwedged before being raised.

Positive closure—even after years of service in the open position. 30° wedges. Gates self-adjusting to seats.

Self-cleaning. Seat rings cleaned throughout entire stroke. No internal guides to cause foul-up.

Ready replacement of parts. Simple construction to ample tolerances.



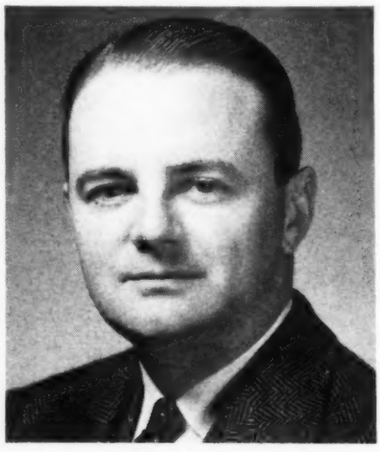
The LUDLOW VALVE MFG·CO·INC· SINCE 1866 TROY·N·Y·

Mid-Continent Representative for A. M. Byers Company

Norman R. Putnam is now Mid-Continent representative for A. M. Byers Company with headquarters in Tulsa, Oklahoma. Putnam is a specialist in wrought iron products and has had a long and successful career in oil-field sales and engineering work dating back to the early days of oil in the Mid-Continent area.

Wm. F. Crawford New President Edward Valve

William F. Crawford, vice-president since 1937, has been elected president of The Edward Valve and Manufacturing Company, Inc., East Chicago, Indiana, filling the vacancy created



WM. F. CRAWFORD

by the death of W. W. Crawford earlier this year. The new Edward company head has been associated with the organization since 1931 and has had active charge of manufacturing, research, advertising, and sales promotion activities for some time.

Jones and Laughlin Announces Expansion

An extension to its present wire rope plant at Muncy, Pennsylvania, and the installation of additional equipment, has been authorized by the Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

Work has begun on a 120-ft. by 275-ft. addition to the plant to house a new closing machine that fabricates the strand into finished rope, and to provide warehouse space. A new office building is also being constructed on the property. The present plant was completed in June, 1938.

Look for the Arm and Hammer

ARMSTRONG BROS.

STUB END WRENCHES

These extra heavy, ruggedly designed Chrome Vanadium Steel Wrenches take long tubular slip-over handles, stand up to long leverage... tighten screws, bolts and nuts far tighter or loosen them even when badly corroded. These are ideal wrenches around rigs, pipe lines and for general heavy duty work. Three types (from 1¼" to 3½") with long hollow tubular steel handles, each of which fits several sizes.

"The Tool Holder People"

331 N. Francisco Ave., Chicago, U. S. A.
Eastern Warehouse and Sales:
199 Lafayette Street New York

Not one Snake bite, but VENEX PAID for itself

"By removing the fear most outdoor workers have of snake bites we increased the effective work of our crews," remarked a foreman of a field gang, "by equipping our men with first aid for snake bites." The VENEX Snake Bite Kit is a *complete* first aid treatment for snake bites. The pocket-size weatherproof metal container holds non-deteriorating syringe, lancet, tourniquet, swabs, adapter, ammonia inhalants, compresses and syringe lubricant with simple, easy-to-follow directions inside the cover.

Ask for bulletin 4053.
E. D. BULLARD CO.,
275 Eighth Street,
San Francisco, Calif.
B-7

Everything BULLARD in Safety

Krause New McEvoy Representative

The McEvoy Company, Houston, Texas, has announced the appointment of B. F. Krause as representative for the Wharton area.

Krause attended Texas A. and M. College and has worked for the last two years with the Oil Lift Supply Company in Kilgore.

B. F. KRAUSE

His Wharton address is 605 Carey Street, phone 429, P. O. box 267.

Jas. A. Trail Joins Hyatt

JAMES A. TRAIL

James A. Trail has joined the Hyatt Bearings Division, General Motors Sales Corporation. For several years Trail has been an associate professor in mechanical engineering at the A. and M. College of Texas. He will cover the Southwest territory, traveling out of Dallas, Texas.

A. J. Swisler, who formerly handled this territory for Hyatt, will henceforth work out of Chicago.

Kobe Holds Division Meeting

At a recent meeting of district managers and representatives of Kobe, Incorporated, pumping problems throughout the Midwest were thoroughly discussed.

Those attending the meeting were: front row, left to right, B. G. Wilkerson, district manager of Oklahoma; P. D. Cornelius, district manager of southern and eastern Texas; H. K. Browning, division sales manager; C. M. Rader, division manager; R. G. Ralph, manager technical service department; W. C. Gilmore, district manager, Texas Panhandle; M. L. Walraven, Jr., district manager, Kansas, and H. K. Ihrig, district manager, Illinois.

Back row, W. F. Slater, Tulsa district representative; E. T. Harrison, Tyler district representative; R. B. Walter, manager of materials department; R. A. Feemster, Oklahoma City district representative; H. W. Wilson, district manager, West Texas district; R. J. Lyons, Dallas district representative; C. E. Buchner, Jr., Houston district representative; J. F. Griffin, purchasing agent, and R. J. Jackson, chief accountant.

FROM JOB to JOB

"The Entirely Different Boiler and Engine Treatment"

One 16-oz. can of Sand-Banum protects one 250-h.p. boiler for one month — just use a few ounces weekly.

So when you finish one job, just take the handy 16-oz. can to the new location. Sand-Banum cans have a safety-tight seal cap.

Sand-Banum does NOT deteriorate, regardless of age or climatic conditions, nor how stored.

And—regardless of water or operating conditions, Sand-Banum definitely removes old and prevents new boiler scale and corrosion.

AMERICAN SAND-BANUM COMPANY, Inc.

9 Rockefeller Plaza
New York City

Stocks carried by

WESTERN SAND-BANUM COMPANY
Houston, Texas Fresno, California
and at other convenient points including leading supply houses

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Export Representatives
PETROLEUM MACHINERY CORP.
30 Rockefeller Plaza New York City

Prout and Glenn Advanced by G-E.

Two appointments have been made in General Electric's industrial department at Schenectady, New York. Effective July 1, G. R. Prout, manager of sales in the department's industrial control section since 1939, has been appointed manager of the industrial control division. R. S. Glenn has been appointed manager of sales, industrial control division, assisting Prout. These announcements were made by J. E. N. Hume, commercial vice-president of General Electric and manager of the company's industrial department.

As of the same date, according to Hume, W. C. Yates has been relieved of his present duties as manager of the control and renewal parts division of the G-E industrial department in order to devote more time to his duties as assistant manager of the department. W. T. Darcy will continue as manager of sales, renewal parts section.

G. R. PROUT

R. S. GLENN

In Los Angeles— Live on the sea-cooled crest of Wilshire

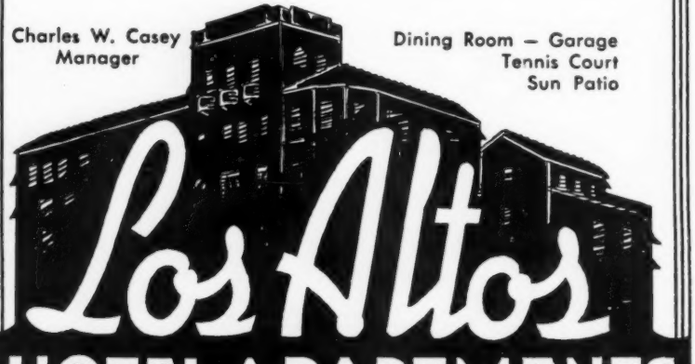
Luxurious accommodations at sensible rates. Located midway between Hollywood, Beverly Hills, the Beaches and downtown Los Angeles.

APARTMENTS, Daily Maid and 24-Hour Switchboard Service from $5 dly.; $90 monthly. Suites from $6 dly.

HOTEL ROOMS, from $3 daily

Charles W. Casey
Manager

Dining Room — Garage
Tennis Court
Sun Patio



Los Altos
HOTEL APARTMENTS

4121 WILSHIRE BOULEVARD . . . NEAR CRENSHAW
LOS ANGELES, CALIFORNIA
Same Ownership Harrison Hotel, Chicago

South Chester Tube Personnel Changes

Edward J. McCann, formerly superintendent, has been appointed general works manager of South Chester Tube Company. McCann has been with this company for 21 years.

E. J. McCANN

W. C. Hale, formerly with the Gypsy Division of Gulf Oil Corporation, at Tulsa, Oklahoma, and more recently in the sales department of South Chester Tube, has been appointed assistant to the general works manager.

Moves Offices and Plant

The offices and plant of the Security Metal Products Company, Inc., manufacturers of Security Locking Nut, have been moved from Kalamazoo to Saugatuck, Michigan.

H. W. Cardwell Celebrates 15th Anniversary as Manufacturer

H. W. Cardwell, president of the Cardwell Manufacturing Company, Inc., Wichita, Kansas, recently celebrated his fifteenth anniversary as a manufacturer of oil-field equipment.

A native Kansan, Cardwell has operated for the most part his own enterprises, spending 14 years in engineering and construction contracting. When he left the construction field for that of industrial and farm machinery, he recognized the opportunity for improvement and development of oil-field machinery.

He organized his own company and entered the oil-field equipment field in 1926 building hoisting units on tractors. Cardwell likes to design, build, and operate machinery and is constantly searching for methods and machines to improve equipment that he manufactures. The latest type machines used in manufacturing oil-field equipment are included in the Cardwell plant in Wichita such as multiple drill presses, special lathes, flame-hardening machines, gear cutters, automatic acetylene and arc-welding machines, and heat-treating furnaces.

Cardwell's first important contribution to the pipe-line industry was the live-boom tractor. Cardwell himself designed the clutches on the hoisting equipment, the brakes, transmission, oscillating type spudder, air valve and a number of other items. Friction clutches, multiple-jaw clutches, roller-type chain, and cut-steel sprockets were first used on oil-field equipment by Cardwell.

A complete line of drilling and servicing equipment as well as pipe-line construction machinery and rigs has been developed by the Cardwell company. In hoisting equipment, Cardwell reduced the weight by using improved grades of steel. The machinery was redesigned and improved and a number of parts that were non-essential eliminated. Using alloy steels reduced the diameter of shafts and made frames stronger and weigh less. Introduction of cut-steel sprockets effects a great saving in weight and improves the efficiency of the rig when roller-type chain in double or multiple strands is used.

Instead of the old heavy double-jaw type, multijaw were used in an improvement of drum clutches by Cardwell. Heat treatment of all wearing parts allowed straps, clevices, pins, bolts, and rods to be reduced in size and increased their strength and wearing qualities.

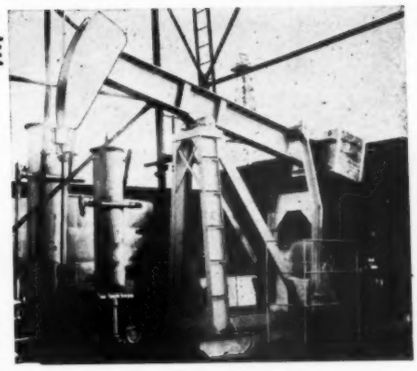
Among the important developments of the company is the self-equalizing self-energizing type brake. It is water cooled and extremely safe, being equipped with double bands capable of supporting at least twice the rated capacity of the drum, and in case of complete failure the shaft will contact lugs on the brake bands and give enough braking power to prevent dropping of the pipe.

Cardwell has developed spudders and other equipment, among them the tractor-mounted rig, the trailer-mounted unit, and the specially mounted Mobilhoist. Cardwell manufactures 34 different units of oil-field equipment and a large engineering staff makes possible service as well as continual improvement for the equipment.

American Iron Remodels Shops

M. G. McCool, general sales manager of American Iron and Machine Works Company, has been in Houston, Texas, Harvey, and New Iberia, Louisiana, for the last several months supervising the complete remodeling of these shops. Much new equipment has been added in each of the branches in order to insure the most modern of shop work. New lathes and certified joint gauges afford greater precision than ever before. The complete rebuilding of used drawworks to either powerize or make them into modern steam units is one of American's specialized services being featured at present. All American shops are equipped to give this service.

Picture of How to Save Money



To the casual reader this picture is a pumping unit. To the man who knows JENSEN JACKS it's a portrait of production economy.

Simple and inexpensive, these units go on and on, doing the job with defense-time efficiency, justifying the fact that they are made by the oldest and largest exclusive manufacturer of pumping equipment in the world.

So if you are putting your house in order for whatever lies ahead, get in touch now with your JENSEN dealer or with us at Coffeyville.

JENSEN BROTHERS MANUFACTURING CO.
Coffeyville, Kansas

For detailed JENSEN JACK description and specifications, see . . . PRODUCING EQUIPMENT DIRECTORY *or* COMPOSITE CATALOG.

EXPORT OFFICE: 50 CHURCH STREET, NEW YORK CITY

. . . this is YOUR OAKITE CLEANING QUIZ !

WANT AN EASIER WAY TO CLEAN YOUR ABSORPTION TOWERS?

Then try the improved Oakite method!

Simply circulate hot solution of recommended heavy-duty Oakite cleaning material through equipment as directed. This thoroughly loosens most sludge and gummy carbon deposits on trays, bubble caps and screens, so that they are easily removed by rinsing. Method saves considerable time and effort . . . provides results far superior to those possible with manual cleaning. Towers are restored to top efficiency.

Complete data is yours FREE for the asking, so won't you write today?

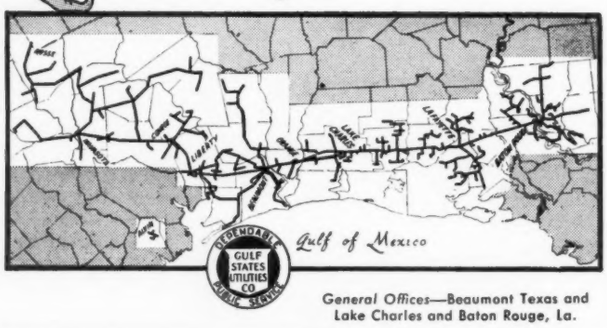
Manufactured only by
OAKITE PRODUCTS, INC. 48 Thames St. New York, N. Y.
Representatives in all Principal Cities of the U. S. and Canada

OAKITE *certified* **CLEANING**
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

PREPARED

To Produce

Plenty of Juice



General Offices—Beaumont Texas and Lake Charles and Baton Rouge, La.

Rockford Plate Clutches

Help Keep Output Up and Costs Down!

Rockford Power Take-Off with O-C Clutch

Rockford Spring-Loaded Clutch

Rockford Plate Clutches and Power Take-Offs help maintain continuous operation economically on a wide variety of engine-powered equipment. The Diesel in the pumping unit illustrated has a Rockford Power Take-Off and O-C Clutch. These rugged products provide notably efficient and durable power control at low cost.

Rockford O-C (Over-Center) Clutches lock in or out of engagement; the Spring-Loaded type works like an automobile clutch. Both are available in Rockford Power Take-Offs which fit standard S.A.E. flywheel housings. Look for Rockford Clutches and Power Take-Offs when buying any engine-powered equipment. Information on request.

Rockford Drilling Machine Division *Borg-Warner Corporation*
1303 Eighteenth Ave., Rockford, Illinois, U. S. A.
Over-Center, Spring-Loaded and Pullmore Clutches

TRADE LITERATURE

What to Write For

COMPLETE DETAILS ON KELLYS manufactured by Baash-Ross Tool Company, Los Angeles, California, may be had by sending your name and address on a post card or letterhead to the company.

BETHLEHEM STEEL COMPANY, Bethlehem, Pennsylvania, offers a new catalog, sent on request, giving information about Bethlehem steels that are available for high temperature work.

INFORMATION ON THE VENEX SNAKE BITE KIT, manufactured by E. D. Bullard Company, 275 Eighth Street, San Francisco, California, will be supplied on request in the company's Bulletin 4053.

PLOMB TOOL COMPANY, 2209 Santa Fe Avenue, Los Angeles, California, will supply without charge a catalog on their new combination box and spud end wrenches.

"THE PIPE OF PROGRESS" containing facts about Republic Electric Weld Line Pipe and Casing will be sent to the reader on request from Republic Steel Corporation, Cleveland, Ohio, or Republic Supply Company, Houston, Texas, or Howard Supply Company, Los Angeles, California.

WRITE TUBE-TURNS, INC., Louisville, Kentucky, for a valuable data book and catalog giving complete details on their new tee and other Tube-Turn seamless welding fittings.

BULLETIN P-132 contains complete details on Twin Disc hydraulic drives manufactured by the Twin Disc Clutch Company, 1370 Racine Street, Racine, Wisconsin. The bulletin will be sent upon request.

"ROPE DOPE," a valuable periodical bulletin filled with information on the use and application of wire rope and issued by Union Wire Rope Corporation, 2106 Manchester Avenue, Kansas City, Missouri, is available on receipt of your name, address, title, and company.

FACTS ABOUT THE GRIZZLY PRESSURE-SEAL ROTARY HOSE are contained in Bulletin No. 20-OF. Address E. M. Smith Company, 600-650 South Clarence Street, Los Angeles, California, or supply houses handling Grizzly hose.

A 1941 CATALOG of pumping equipment may be obtained by writing The Oil Country Specialties Manufacturing Company, Coffeyville, Kansas, and Houston, Texas.

NATIONAL CARBON COMPANY, INC., is offering a bulletin giving full information on "National" Carbon Raschig Rings. Address National Carbon Company, Inc., Cleveland, Ohio, stating name, firm, and address.

DESCRIPTIVE LITERATURE on the Marmon-Herrington all-wheel-drive will be sent to the reader who addresses Marmon-Herrington Company, Inc., Indianapolis, Indiana.

FOR INFORMATION ON VALVES, boiler mountings, and lubricating devices address The Lunkenheimer Company, Cincinnati, Ohio, or your nearest Lunkenheimer distributor for Catalog 78.

READERS DESIRING FACTS, description, and specifications of cores— side wall or bottom hole—should write Hunt Tool Company, Houston, Texas, for the Hunt 20-page catalog.

CATALOG NO. 41 OF THE GLOBE OIL TOOLS COMPANY, Los Nietos, California, contains descriptions, specifications, and photos of Globe rock bits. The catalog may also be obtained from the nearest Globe distributor.

"PIPE PROTECTION" describes the process in detail of pipe coating as done by General Paint Corporation, Hill, Hubbell and Company Division, Cleveland, Ohio.

A COPY OF AN ILLUSTRATED CATALOG describing Fluid Packed Pumps will be sent on request by Fluid Packed Pump Company, Box 64, Los Nietos, California.

A SPECIAL ENGINEERING BULLETIN that describes in detail the methods employed by Stoody Company, 1134 West Slauson Avenue, Whittier, California, in hard-facing tool joints is available on request.

DURAMETALLIC CORPORATION, Kalamazoo, Michigan, will send on request an illustrated bulletin describing their oil pressure unit.

THE CHAPLIN-FULTON MANUFACTURING COMPANY, 28-40 Penn Avenue, Pittsburgh, Pennsylvania, offers full details on the Fulton V-Port motor valve in Bulletin 3259.

BROWN INSTRUMENT COMPANY offers a 180-page book covering instrumentation and automatic control applications in the oil refining industry to consultants and refinery engineers requesting it on company letterhead. Address Brown Instrument Company, 4475 Wayne Avenue, Philadelphia, Pennsylvania.

FOR INFORMATION ON THE QUILL BEARING write for Bulletin P-104 offered by the Bantam Bearings Corporation, South Bend, Indiana.

HELPFUL AND TECHNICAL LITERATURE on orifice measurement and its modern applications may be obtained from The American Meter Company, Inc., New York, New York.

CYCOIL BULLETIN NO. 130D gives complete information on the operation of Cycoil air cleaners, available on request, manufactured by American Air Filter Company, Inc., 18 Central Avenue, Louisville, Kentucky.

BULLETIN G-MV of The Cooper-Bessemer Corporation describes in detail specifications and performance of the Type G-MV compressor. Address your nearest Cooper-Bessemer distributor.

CATALOG C-39, describing Armstrong Bros. Tool Company products is available upon request. Address Armstrong Bros. Tool Company, 331 North Francisco Avenue, Chicago.

THE INTERESTING STORY of their portable laboratories and services available throughout the United States is told in Bulletin "A" of Core Laboratories, General Offices, Santa Fe Building, Dallas, Texas.

A DESCRIPTION OF MONARCH WIRE LINE manufactured by Macwhyte Company of 2942 Fourteenth Avenue, Kenosha, Wisconsin, is available in catalog form.

INFORMATION ON REED VALVES is available in a new 1941 catalog. Address Reed Valve Division, Reed Roller Bit Company, Post Office Box 2119, Houston, Texas.

FILL IN

YOUR NAME .....

YOUR TITLE .....

COMPANY .....

ADDRESS .....

and return to us

You'll get "ROPE DOPE"

"ROPE DOPE" is a valuable periodical bulletin filled with information, not advertising. You'll want every copy in your reference file for uses and application of wire rope. There is no charge for it. To be on our mailing list, simply send us the information asked for above.

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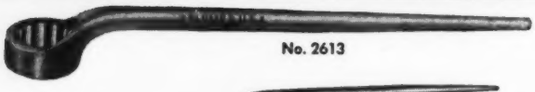

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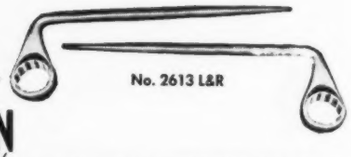

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Book Reviews

Lessons in Arc Welding. Published by The Lincoln Electric Company, Cleveland, Ohio. 176 pp., 170 illus. Price 50 cents postpaid in U. S. A., 75 cents elsewhere.

A series of 60 lessons, based on the experiences of Arthur Madson, instructor in The Lincoln Electric Company school, presenting the fundamental facts of welding, the knowledge of which will enable the welder to utilize the process successfully and economically. Text explanations are graphically supplemented by drawings and photos for ready understanding.

Through the book is made available to industry, engineering colleges and universities, and trade and vocational schools, the accumulated welding instruction information from The Lincoln Welding School, in operation for 24 years. According to the company, the book, in early editions, has become the standard text book of educational institutions throughout the country that now include courses in arc welding as a regular part of the curriculum.

Considered a valuable feature of the book is the set of questions and answers for each lesson enabling the student to check his knowledge of welding.

The book should be invaluable, at this time, to any industrial organization faced with the necessity of training its own welders to meet demands imposed by the National Defense program.

●

The Federal Labor Laws (The Wagner Act, The Wages and Hours Act, and The Walsh-Healey Act), by Russell L. Greenman and Leslie L. Sanders. National Foremen's Institute, Inc., Deep River, Connecticut. 40 pp. Price $1.50.

Written especially for supervisors, foremen, department heads, and those in business and industry who have men working under their direction and upon whom the Wagner Act has imposed certain limitations in their dealings with workers and who are also affected by the Wages and Hours Act and Walsh-Healey Act, the manual contains a brief, but clear and concise summarization of the important features of the three acts. The book is written in a language easily read and understood.

In the section of the book devoted to the Wagner Act, the author, although not attempting to give a complete study of the act, does explain completely the purpose of the act and the details of great importance to foremen and other supervisors. Some discussion of the penalties invoked for violation of the act is given.

A clearly written presentation is made by the author of the principals of the federal Wage-Hour Act because it directly affects the duties of virtually all department heads and other supervisors working for companies engaged in industry and commerce.

A brief analysis of the text of the Walsh-Healey Act is made by using fictituous characters employing 15 simple questions and answers illustrating important points of the act.

●

Fire-Hazard Properties of Certain Flammable Liquids, Gases and Volatile Solids, compiled by committee on flammable liquids of the National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts. 48 pp. Price 25 cents.

This table, sponsored by the N.F.P.A. committee on flammable liquids, was originally presented at the 1935 annual meeting of the association and published in separate pamphlet form. In 1937 it was reissued with minor revisions. The present edition incorporates extensive new material.

MEETINGS

American Chemical Society—September 8, 9, 10, 11, and 12, Atlantic City, New Jersey.

National Petroleum Association, 39th Annual Meeting—September 17, 18, and 19, Hotel Traymore, Atlantic City, New Jersey.

Society of Automotive Engineers, National Tractor Meeting—September 25 and 26, Schroeder Hotel, Milwaukee, Wisconsin.

National Lubricating Grease Institute, Ninth Annual Meeting—September 29 and 30, Stevens Hotel, Chicago, Illinois.

West Virginia Oil and Natural Gas Association, Annual Convention—October 2 and 3, Clarksburg, West Virginia.

National Safety Congress—October 6 and 8, Stevens Hotel, Chicago, Illinois.

Texas Mid-Continent Oil and Gas Association, Annual Meeting—October 9, 10, and 11, Beaumont, Texas.

American Association of Petroleum Geologists—October 16 and 17, Los Angeles, California.

American Institute of Mining and Metallurgical Engineers, Petroleum Division—October 16, 17, and 18, Dallas, Texas.

Independent Petroleum Association of America, Twelfth Annual Meeting—October 20, 21, and 22, Tulsa, Oklahoma.

Society of Automotive Engineers, National Fuels and Lubricants Meeting—October 23 and 24, Mayo Hotel, Tulsa, Oklahoma.

American Institute of Mining and Metallurgical Engineers, Petroleum Division—October 30 and 31, Los Angeles, California.

California Natural Gasoline Association—October 31, Los Angeles, California.

American Petroleum Institute, 22nd Annual Meeting—November 3, 4, 5, 6, and 7, San Francisco, California.

New Mexico Oil and Gas Association—December 3, Artesia, New Mexico.

Oklahoma Stripper Well Association—December 5, Tulsa, Oklahoma.

American Institute of Electrical Engineers, Southeastern District—December 3, 4, and 5, New Orleans, Louisiana.

Society of Automotive Engineers, Annual Meeting (and Engineering Display)—January 12, 13, 14, 15, and 16, Book-Cadillac Hotel, Detroit, Michigan.

Texas Oil and Gas Association—February 28, 1942, Wichita Falls, Texas.

American Society of Mechanical Engineers, Spring Meeting—March 23, 24, and 25, 1942, Houston, Texas.

National Petroleum Association, Thirty-ninth Semi-Annual Meeting—April 16 and 17, Cleveland, Ohio.

International Petroleum Exposition—May 16, 17, 18, 19, 20, 21, 22, and 23, 1942, Tulsa, Oklahoma.

American Society of Mechanical Engineers, Semi-Annual Meeting—June 8, 9, 10, and 11, 1942, Cleveland, Ohio.

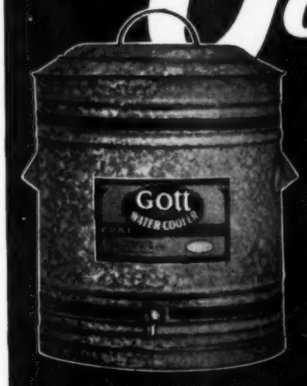
American Society of Mechanical Engineers, Fall Meeting—October 12, 13, and 14, 1942, Rochester, New York.

Close Dallas Office

R. A. Williams, manager of the Dallas, Texas, office of Chicago Bridge and Iron Company, has been called for active service in the Navy. For the time being the company will close its Dallas office and serve its customers in the Southwest from the Tulsa and Houston offices.

Gotkool

WATER CANS & COOLERS



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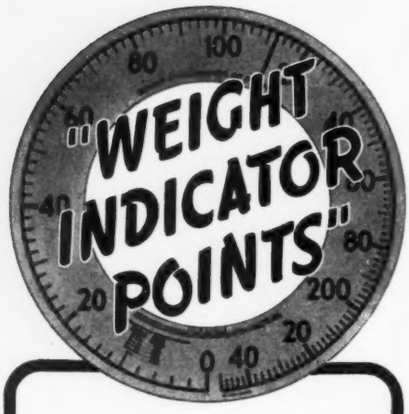

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